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THE UNIVERSITY OF HONG KONG

AN EMPIRICAL STUDY OF THE IMPACT OF RAILWAY EXTENSIONS TO PRICES OF RAILWAY RESIDENTIAL PROPERTIES

A DISSERTATION SUBMITTED TO

THE FACULTY OF ARCHITECTURE

IN CANDIDACY FOR THE DEGREE OF

BACHELOR OF SCIENCE IN SURVEYING

DEPARTMENT OF REAL ESTATE AND CONSTRCUTION

BY

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HONG KONG

APRIL 2009

DECLARATION

I declare that this dissertation represents my own work, expect where due acknowledgement is made, and that it has not been previously included in a thesis, dissertation or report submitted to this University or to any other institution for a degree, diploma or other qualification.

Signed:______________________________

Name:_______________________________

Date:________________________________

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ABSTRACT

Railway systems are the crucial public transportation in Hong Kong. Railway extension is a kind of transportation improvement that would affect the real estate market, especially railway residential property prices. Little previous literatures have studied effects of a railway extension to railway residential properties along the railway line. This study is to investigate how a railway extension may affect railway residential property prices and compare effects of a CBD extension to that of a non-CBD extension.

Two hypotheses are established with respect to the research objectives. They are:

1) ***A railway extension will lead to a decline in the price gradient of railway residential properties.***
2) ***A railway extension to the CBD will lead to a greater decline in the price gradient of railway residential properties than that to a non-CBD district.***

To test the hypotheses, two railway extensions are selected to build up the model of CBD extension and that of non-CBD extension. They are East Tsim Sha Tsui extension and Lok Ma Chau extension of the East Rail Line. Transaction data from four railway residential estates in Hung Hom, Tai Wai, Tai Po Market and Sheung

Shui are used for construction of price gradients in the two models.

Hedonic price model is the key research method applied to analyze the data. An interactive independent variable is used to study the impact of a railway extension on the price gradient of railway residential properties. The interactive independent variables from the two models are compared with association of unpaired t-test to investigate the difference of railway extensions to the CBD and those to a non-CBD district on the price gradient.

The results show that the first hypothesis cannot be refuted. A railway extension will significantly reduce the price gradient of railway residential properties. Nevertheless, the second hypothesis can be refuted by the results. A CBD extension may not affect the price gradient to decrease in a greater extent. It is believed that the unexpected results are due to the border nature of Lok Ma Chau Station and the need of people choosing to live in Sheung Shui. A proportion of people choosing to live in Sheung Shui are believed to be those need to travel between Hong Kong and mainland China more often. The accessibility and transportation costs to destinations in mainland China are more crucial factors they considered. The results provide insight for people’s expectation of transportation improvement at a border area.

TABLE OF CONTENTS

CHAPTER 3: LITERATURE REVEW

CHAPTER 4: RESEARCH METHODOLOGY

CHAPTER 5: EMPIRICAL RESULT AND ANALYSIS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1: INTRODUCTION

1.1 Background

It is well known that the transportation infrastructure always plays a crucial rule in the development of a region. It brings significant effects to the real estate market.

The population density in Hong Kong is extremely high. Within the land area of 6,500 hectares, the population has reached approximately 7 million. Under the high population density, outstanding and efficient public transportation systems are required. There are various kinds of public transports available for citizens in Hong Kong. According to the recent statistics from Transportation Department (2008), railways are the public transports with most average daily passengers. Railways are relative popular within public transports due to their efficiency, safety and regularity.

From the government's point of view, railways are welcomed because they help to solve traffic congestions and reduce environmental problems. The first policy objective of Transport and Housing Bureau (2009) is to plan for and implement the construction and improvement of the transportation infrastructure, with emphasis on railways. The government supports the continuous development of railways in Hong Kong. The long term goal is to increase railway's share of public transportations to 45% of journeys in 2016. At that time, it is expected that about 70% of the population as well as 80% of jobs in Hong Kong will be located within 1km of a railway station.

The important role of railways in Hong Kong is obvious. Railways are regarded as an efficient and cheap public transportation. Therefore, people would like to live near railway stations. Residential properties are thus developed near railway stations to fulfill the demand. When railways in Hong Kong are further developed, more residential properties are built near stations at the same time. These residential properties are usually called railway residential properties. "5 minutes walk to a railway station" is their common selling point. There is no formal definition for railway residential properties. In this study, railway residential properties are defined as those located at a distance within 100 m and 5 minutes walk from a railway station.

1.2 Objectives

Being the public transportation with most passengers in Hong Kong, railways have never stopped to extend their network to meet the demand. There will be more new railway lines to be developed in the coming future. Railways are generally the main way of transportation to residents of railway residential properties. Prices of railway residential properties along the line should respond to a railway extension most sensitively. Although many studies have done on the effects of introducing a new railway line or other transportation improvements to nearby residential property prices, little is done on the effects of a railway extension to prices of railway residential properties along the railway line. This study focuses on examining how railway extensions may affect prices of rail residential properties. Hence the first objective is:

1) To investigate the effect of railway extenstions on prices of rail residential properties

When reviewing former cases of railway extensions in Hong Kong, it is discovered that railways are extended to business and employment central areas in some cases while sometimes they are extended to rural areas. Railway extensions can be classified as those to the central business district (CBD) and those to a non-central business district (non-CBD district). It is significative to explore the effect of two kinds of railway extensions on prices of railway residential properties. Hence the second objective is:

2) To investigate the difference of railway extenstions to the CBD and those to a non-CBD district on prices of rail residential properties

After investigating the effects of railway extensions, it is expected that the results of this study can provide references to the government and railway companies in implementing railway development plans that meet the future needs of the society. For developers, the results can give a clear direction to identify profitable locations and appropriate time for developments. Some hints of setting suitable price levels of railway residential properties can also be obtained. In addition, a prediction on the effects of future extensions, including Kowloon Southern Link, Sha Tin to Central Link, South Island Line and Kwun Tong Line Extension, to the railway residential properties can also be made.

1.3 Rationale of Study

To other to achieve the objectives of this study, previous literatures and studies are first reviewed, especially those about relationship between location and land value, relationship between transportation, accessibility and land value, the impact of transportation improvements on property prices and the typical model for empirical tests. Then hypotheses corresponding to the objectives are set up. To test whether the hypotheses, an appropriate model should be selected and adopted. Residential properties have a heterogeneous nature. The model adopted should be able to control the effects of other irrelevant factors.

After selecting the appropriate model, transaction data of targeted rail residential properties are collected. The size and type of transaction data collected are determined by the requirement of the model.

The transaction data can then be processed by the model to produce empirical results. Through analyzing the empirical results, the validity of the hypotheses can be determined.

1.4 Organization

This dissertation composes of six chapters. A brief introduction to objectives and rationale of the study is given in Chapter I. The background information of the study is provided in Chapter II. The railway development and rail residential properties in Hong Kong are described.

In Chapter III, previous literatures regarding relationship between location and land value, transportation and land value, the impact of transportation improvement and hedonic price model are reviewed.

Then in Chapter IV, the research methodology is discussed. Hypotheses, subjected targets, methods for empirical tests, variables used, regression equation and details of data collection are explained.

The empirical results are analyzed in Chapter V. The implication from the results is used to test whether the hypotheses can be refuted or not. Finally, conclusions are drawn in Chapter VI. Limitations of the study and areas of further study are also discussed.

CHAPTER 2: BACKGROUND OF STUDY

2.1 Introduction

This study mainly focuses on the effects of railway extensions in Hong Kong. In order to have a better understanding, the historic background and future development of railways in Hong Kong is discussed in this chapter. More detail information about the East Rail Line is explained as it is the targeted railway studied in this research.

2.2 History of Local Railway

In Hong Kong, railways have a long history. Park Tram is the earliest mode of rail transportation. It started its operation in 1888. At that time, the use of railways was limited. People had not yet used railways for daily transportation.

Kowloon-Canton Railway (KCR) was opened in 1911. It was initially a rail link between Kowloon in Hong Kong and Guangzhou in Mainland China. The trains at that time were steam-hauled. The section of KCR on Hong Kong side was a 35 km long single track system with nine stations located in New Territories and Kowloon

(KCR Corporation, 2009).

During 1970s and 1980s, as New Territories was under rapid development and urbanization, KCR became an essential route for connecting new towns in eastern New Territories with Kowloon. Its service was improved continuously during this period. The replacement of steam-hauled trains by diesel-powered trains, installation of double track system and electrification of the railway system had improved the service of KCR to a higher level.

KCR originally had only one railway line in Hong Kong. In 1996, a western corridor railway was decided to be constructed. In 2003, KCR West Rail running from Nam Cheong to Tuen Mun was opened. It intercepted with Tsuen Wan Line and Tung Chung Line of MTR. The original KCR was then called KCR East Rail. About 1 year later, KCR Ma On Shan Rail was also opened as a branch line of KCR East Rail. The Ma On Shan Rail consists of 9 stations. It starts at Tai Wai and ends at Wu Kai Sha (KCR Corporation, 2009).

In late 2004 and mid-2007, there were two extra extensions to KCR East Rail Line. East Tsim Sha Tsui Station and Lok Ma Chau Station were opened respectively (KCR

Corporation, 2009). KCR became a railway with 33 railway stations spreading over New Territories and Kowloon as shown in Figure 1.

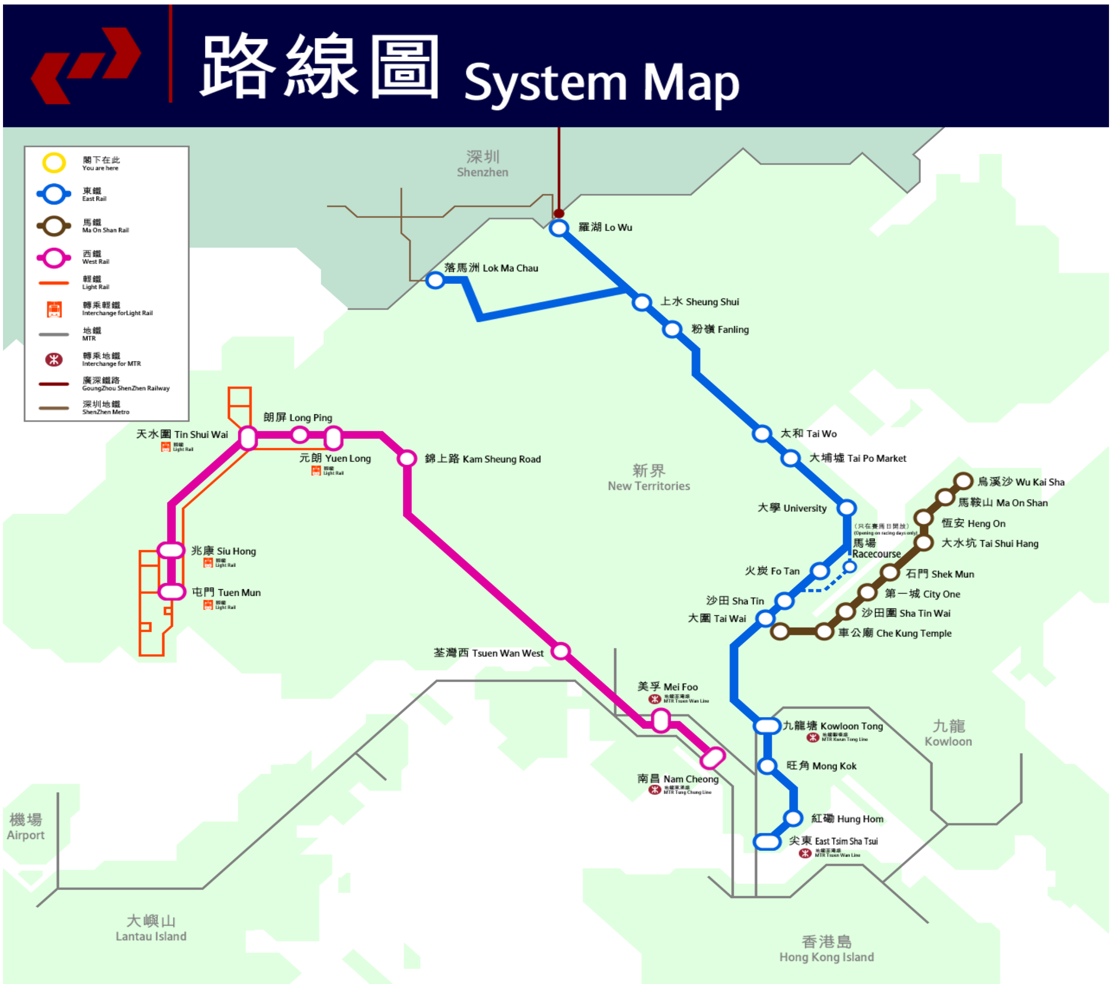

Figure 1: KCR system in 2007

Source: KCR Corporation (2009)

Mass Transit Railway (MTR) is a rapid-transit railway system. It was first proposed by the Road Research Laboratory in 1960s. It aimed at decentralization and reducing traffic congestion problems. The first line operated was the early Kwun Tong Line. It had 15 stations from Kwun Tong to Central. It started its service in three stages from 1979 to 1980 (MTR Corporation, 2009).

The second line of MTR connected Tsuen Wan directly to Central. It was the Tsuen Wan Line opened in 1982. It jointed with the early Kwun Tong Line at Yau Ma Tei Station (MTR Corporation, 2009). MTR at that stage had already linked up Hong Kong Island, Kowloon and New Territories.

The third line of MTR was the Island line which consisted of 14 stations between Sheung Wan and Chai Wan. The whole line fully started its operation in mid-1986. The Island line was extended after the opening of Eastern Harbour Crossing tunnel. A branch line passing through Eastern Habour Crossing tunnel from Quarry Bay Station to Kwun Tong Station was constructed 4 years later (MTR Corporation, 2009).

The network of MTR was modified and developed continuously. In 1998, MTR was further extended to Lantau Island due to the opening of the new Hong Kong International Airport in Chek Lap Kok. There were two new lines including Tung Chung Line and Airport Express (MTR Corporation, 2009).

In 2000s, the network of MTR was further extended. The branch line connecting Island Line and Kwun Tong Line was extended from Quarry Bay to North Point via a tunnel in 2001. One year later the branch line was developed into Tseung Kwan O Line. It connects North Point to Po Lam. Disneyland Resort Line providing service to Hong Kong Disneyland Resort was opened in 2005. It links Sunny Bay to the Disneyland Resort. The resort is an area designed to blend in with Hong Kong Disneyland to give a resort ambience (MTR Corporation, 2009).

In 2006, a non-binding memorandum of understanding was signed by Mass Transit Railway Corporation Limited (MTRCL) and Kowloon-Canton Railway Corporation (KCRC) to merge the operation of the two railways, MTR and KCR. They were officially merged on 2nd December, 2007. MTRCL was allowed to take over the operation of the KCR and the whole railway network was still called MTR in English. Since merging with KCR, the network of MTR has included three more lines, which are the East Rail Line, the West Rail Line and the Ma On Shan Line (MTR Corporation, 2009). The whole railway consists of 100 railway stations and covers most areas of Hong Kong as shown in Figure 2. The details of various lines of MTR are listed in Table 1.

Figure 2: Railways in Hong Kong

Source: MTR Corporation (2009)

Line	Opening Year	Terminus		Stations
East Rail Line	1911	East Tsim Sha Tsui	Lo Wu / Lok Ma Chau	15
Kwun Tong Line	1979	Yau Ma Tei	Tiu Keng Leng	15
Tsuen Wan Line	1982	Central	Tsuen Wan	16
Island Line	1986	Sheung Wan	Chai Wan	14
Tung Chung Line	1998	Hong Kong	Tung Chung	8
Airport Express	1998	Hong Kong	AsiaWorld-Expo	5
Tseung Kwan O Line	2002	North Point	Po Lam	7
West Rail Line	2003	Nam Cheong	Tuen Mun	9
Ma On Shan Line	2004	Wu Kai Sha	Tai Wai	9
Disneyland Resort Line	2005	Sunny Bay	Disneyland Resort	2

Table 1: Details of railway lines of MTR

Source: MTR Corporation (2009)

2.3 Future Development of Local Railway

To cope with the demand for railway services due to rapid development of Hong Kong, MTR will have further extension and new lines in the future.

Tseung Kwan O Line will have a southern extension. A new station serving the Tseung Kwan O Area 86 development will be opened. The Tseung Kwan O Line train service will bifurcate at Tseung Kwan O Station with trains running north to existing Po Lam Station, as well as south to the new station. The new extension will start to operate in 2009 (MTR Corporation, 2009).

Kowloon Southern Link will operate to link East Rail Line's East Tsim Sha Tsui Station with West Rail Line's Nam Cheong Station. This new 3.8 km long rail link aims to serve the strategic function of allowing passengers of West Rail Line to have direct access to East Rail and vice versa. The link will involve a new station, Austin Station, which is under construction (MTR Corporation, 2009).

The projects of Shatin to Central Link and Kwun Tong Line Extension were approved by the government in March 2008. The detailed designs and implementation details for these two projects are under preparation. Once the designs and details are agreed by the government, construction of Shatin to Central Link and Kwun Tong Line will be commenced. Apart from these, two additional railway lines for Hong Kong Island, West Island Line and South Island Line (East), are under preliminary planning and design on the government's request (MTR Corporation, 2009).

2.4 East Rail Line

East Rail line takes a crucial role in this study. The background of the East Rail Line is thus emphasized. East Rail Line was originally owned by KCR and called KCR East Rail before merging.

In 1910s, KCR provided service only from Yau Ma Tei to Fanling with a tunnel through Beacon Hill. New Towns were developed along the line rapidly. The immense growth in population along the line enhanced the demand for railway service. Apart from adopting a double track system, the line was redeveloped during 1970s to meet the demand. Due to its small size and limitation in expansion, the Kowloon Station, which originally located at Tsim Sha Tsui, was moved to Hung Hom. The replacement of the old Kowloon Station at Tsim Sha Tsui was taken in 1974. Hung Hom became the terminus of the line at that time (KCR Corporation 2009).

In 1982, in order to rise the efficiency of the system and reduce pollution, the diesel-powered locomotives were replaced by new electric multiple units. Apart from electrification, more new railway stations were added during that period. The rapid development of the line can be also seen during 1990s and 2000s. In 1996, trains of the line were refurbished into modernized models, Metro Cammell EMU, which allowed passengers to traverse from one car to another (KCR Corporation 2009).

Extra stations were continuously added to the line through the years. East Rail Line now has totally 15 railway stations from Lok Ma Chau and Lo Wu to East Tsim Sha Tsui. Among the 15 railway stations, East Tsim Sha Tsui Station and Lok Ma Chau Station are the newest extensions of the line (KCR Corporation 2009).

East Tsim Sha Tsui Station was opened on 24th October, 2004. It is extended from Hung Hom Station through a tunnel under Salisbury Road and located at Signal Hill of Tsim Sha Tsui. It takes the role of Hung Hom Station to serve as the southern terminus of East Rail Line. Its opening labels the return of East Rail Line to Tsim Sha Tsui after 30 years (KCR Corporation 2009).

The station aims at easing surface traffic jams to Tsim Sha Tsui and congestion of passengers at Kowloon Tong Station, which is the interchange station for Kwun Tong Line. As it is connected with Tsim Sha Tsui Station of Tsuen Wan Line, one more interchange station is provided to passengers.

Among railway stations along East Rail Line, East Tsim Sha Tsui Station is the only underground station. It has 2 platforms, 11 exits and several shops. Tsim Sha Tsui Station of Tsuen Wan Line has already got well-developed linkage to other transports. East Tsim Sha Tsui Station can take advantages from that and no other transport terminus is required and constructed together with it (KCR Corporation 2009).

In the future, East Tsim Sha Tsui Station will not act as a terminus of East Rail Line. Once West Rail Line is extended to joint East Rail Line through Kowloon Southern Link, the station will be an intermediate station to link up the two railway lines. After that, a new line combining West Rail Line and East Rail Line will be formed.

Another recent extension of East Rail Line, Lok Ma Chau Station, was opened on 15th August, 2007. It is the northern terminus of the line and extended form Sheung Shui to Lok Ma Chau. It acts as an intermediate point between Hong Kong and mainland

China and aims at alleviating passenger congestion at Lo Wu Station (KCR Corporation 2009).

Lok Ma Chau Station is an elevated station. It contains with 2 platforms and 2 exits. There is a public transport interchange located at the east of Lok Ma Chau Station (KCR Corporation 2009).

Lok Ma Chau Station is located at a region regarded as Frontier Closed Area. It is connected to Fu Tian Kou An Station of Shenzhen Metro via an immigration control point. Passengers can travel by Shenzhen Metro or other transports to other parts of mainland China after passing through the immigration control point.

The immigration control point associated with Lok Ma Chau Station is called Lok Ma Chau Spur Line Control Point, which contains a pedestrian footbridge and immigration facilities. The pedestrian footbridge across Sham Chun River is the border between Hong Kong and mainland China. The immigration facilities are located at the two ends of the pedestrian footbridge. The number of commuter using the control point keeps increasing after its opening (KCR Corporation 2009).

CHAPTER 3: LITERATURE REVIEW

3.1 Introduction

Relevant literatures studying the relationship between location and land value, relationship between transportation, accessibility and land value, effects of transportation improvements and hedonic price model are reviewed in this chapter.

Transportation and location are interrelated. Before studying how transportation and accessibility affects the land value, the literatures about how land value is affected by location is reviewed. Then empirical studies of the impact of transportation improvements are collected and analyzed.

3.2 Location and Land Value

Location is an important factor affecting land value. The relationship between them is studied in term of rent of agricultural land early in Ricardo's book. Ricardo (1963) claims that rent is paid to the landlord for the use of the original and indestructible power of the soil. It is equal to the difference between the produce obtained by the employment of the same quantities of capital and labor in two different agricultural lands. As land is not unlimited in quantity and uniform in quality, the increase in demand of land will cause cultivation of land. The most fertile and favorably situated land will be first cultivated. This is followed by land with inferior quality. When same level of capital and labor is applied to the cultivation of land with inferior quality, the product of the land with inferior quality is less than that of fertile land as the fertile land cultivated earlier has stronger productive power. Therefore, rent commences on the fertile land. This leads to higher rent in more fertile and favorably situated land but lower rent in less fertile and favorably situated land. In other word, when a land located at a position with higher fertility and productivity, more rent can be received by the landlord of that land.

The principle of rent of agricultural land is then further developed by Thünen. Thünen (1966) studies the effect of location to the rent of agricultural land in another point of view. He uses an assumed isolated state as the studied model. It is a state of fertile plain with a large town at the centre and the central town is isolated from the outside world. There are grain farms surrounding the central town. Throughout the plain the soil is assumed to be capable of cultivation and of the same fertility. Therefore, the impact of fertility to rent suggested by Ricardo is not defined in this model.

Thünen (1966) suggests that there are grain farms surrounding the central town and located at different distance from it. The central town is the only market for grain. He states 'grain cannot be as valuable in the rural areas as in the town, because, in order to fetch its market price, it must first be taken to the town. It follows that in the country districts grain is less valuable than in the Town by the cost of its transport.' He estimates the decline in value of grain with distance from the market by an illustration taken from the real world. Then he tries to find out the land rent of grain farms at different distance from the town in his model. In his calculation, the land rent is the net product remained when the production costs are subtracted from the value of grain. He finds that the rent of grain farms decrease when they are located more far from the town of the isolated state. His study mentions that the price at the market is the same for products at different location, but the transportation costs of products are increased with the distance from the market. The increase in the transportation costs will reduce the value of products in the agricultural area in order to maintain the price of products at the market. This leads to a decrease in rent of agricultural land as the rent is believed to be the difference between the value of products in the agricultural area and the production costs. As the rent is arising from the more favorable situation of the site as compared with the marginal site, later scholars call that situation rent.

The theory of situation rent is then incorporated into the studies of later scholars. Mill (1973) has analyzes the land rent in different locational situations. From his study, the land rent of a house in a small village is little higher than the rent of a similar patch of land in the open fields. Then the land rent of a shop in Cheapside, which is an expensive trading area in London, is relatively high. He explains that this is due to people's estimation of the superior facilities of money-making in the more crowded place. Hurd (1903) also claims, 'since value depends on economics rent, and rent on location and location on convenience, and convenience on nearness, we may eliminate the intermediate steps and say that land value depends on nearness.' This means that the land value is enhanced by the convenience of a location. Mill and Hurd also believe in the cause and effect relationship between more advantageous locational situation and higher rent.

Haig initiates his theory on relationship between location and land rent by studying the effect of the centre of the city. Haig (1926) treats the centre of the city as the most advantageous place within the city. It is the place possessing the essential quality of physical proximity or accessibility to all other parts of the city. All activities with concentric circles of influence coinciding with this centre will treat the centre as the most convenient location. Then people will compete for the ownership or the privilege of occupying this favorable space by giving a high bid. The rent of site at the centre of the city thus stays at the relatively highest level. For the area outside the centre of the city, the site rent will increase steadily when the location of the site is staying closer to the centre of the city due to the greater convenience and the decline of the loss of time in connection with the pursuit of business.

It is important to notice that the degrees for different activities to make effective use of the essential quality of physical proximity or accessibility provided by the centre of the city are different. This means that different activities are differ in the ability to turn accessibility into profits. As the relative size of the bids on the site is fundamentally determined by the degree to which the various activities can profitably utilize sites, the rent of the site also depends on the type of activity occupying the site in addition to the distance from the centre of the city (Haig, 1926).

Alonso is another scholar famous in studying the relationship between land rent and distance from the centre of a city. He has extended Thünen and Haig’s model from agricultural land to urban land. He develop a model which treats land rent, apart from land use, intensity of land use, population and employment, as one of functions of distance to the centre of a city. The bid rent curves developed Alonso have been the basis for studies of later scholars such as Alcaly. Alonso (1966) states that an economic man who wishes to buy some land to live in a city will be faced with the double decision of how large a lot he should purchase and how close to the centre of the city he should settle. The distance from the centre of a city becomes an importation issue affecting the level of satisfaction of an individual to occupy a lot. As the level of satisfaction to occupy a lot should be constant throughout a city, when a lot is staying further away from the centre of the city, an individual would pay a price to buy sufficient amount of land as much satisfaction as a given price and amount of land at the city centre. Therefore, a basic bid rent curve possesses a constant level of utility as shown in Figure 3. Along the bid rent curve, the price the individual will bid for a land will decrease with the distance from the centre at a rate just sufficient to produce an income effect which will balance to his satisfaction the increased costs and the brother of a long trip (Alonso, 1960). Thus the bid rent curve has a negative slope.

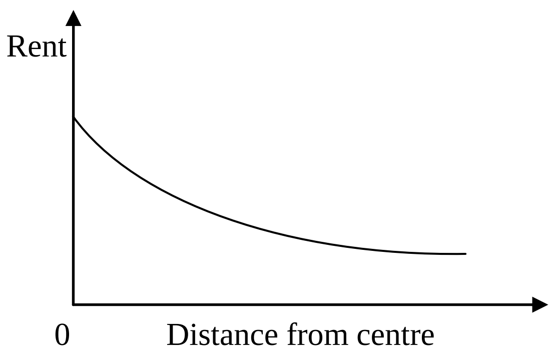

Figure 3: Basic bid rent curve

Source: Alonso (1960)

Apart from basic bid-rent curve, Alonso (1966) also develops a residential bid rent curve which is a set of prices for land the individual could pay at various distances while deriving a constant level of satisfaction. An individual will have same level of satisfaction at different locations if land rents vary with the distance from the centre of a city the residential in the manner as the residential bid rent curve. In the residential bid rent curve shown in Figure 4, the bid rent curves for a household is intersected with the bid rent curve of general residential market to obtain the most preferable location *t*, at where the profit for a household is maximized in the general market. The corresponding rent will be paid for the location *t*.

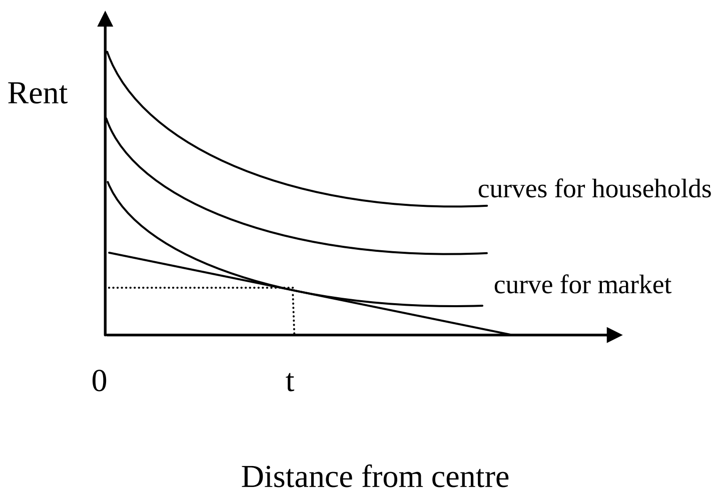

Figure 4: Residential bid rent curve

Source: Alonso (1960)

Ratcliff (1949) states that the location of the site is the most important variable determining the net return of an urban site. The location is primary in determining, on the one hand, the level and pattern of gross income of the site, and, on the other hand, the costs or charges against this income. The net return is proportional to the rent of the site. He agrees that the differences in fertility and location account for the differentials in rent of agricultural land. But the rent of urban land is determined mainly by location.

In an efficient city structure, the places of related functions are located adjacently in order to obtain spatial efficiency. Ratcliff (1949) describes this philosophy of related land uses as space relationships. Space relationships is a component of efficient city structure within which all the functions of working and living can be carried on with the minimum of time and money costs of travelling from one place to another. At any given point in time, each urban site is fixed within a set of space relationships with all other sites. The set of space relationships has significance mainly in terms of the use that is made of all other sites and the human activities that go on at those points. He points out that the site of a particular use can gain greatest location advantages when the set of space relationships associated with the site is most favorable for that use. The location advantages can be translated into an economic rent paying capacity, thus the site can be bidden at the highest rent at that location (Ratcliff, 1949). This means that if the location of a site of a particular use is associated with sites of most favorably related uses, the rent of the site at that location will be maximized. This theory is important to the study of relationship between location and land value as it consider the factor of land use.

By the impact of previous studies, some scholars develop a strong interest to investigate upon the question what causes the location to change. Marshall (1961) speaks of the fact that a rise in rent may cause a manufacturer to move into another town or into the country. Although he does not give a reason of such rise in rent in the first instance, he gives an interpretation of the relationship between location and land rent in another standpoint. Weber is another scholar interested in this question. His study is usually compared with that of Thünen as they have similar assumption in creating the model. Both Weber (1958) and Thünen (1966) have assumed an absolutely even plain and equal transportation rates throughout. However, Weber (1958) does not assume one consuming centre and equal fertility throughout. Instead, many consuming centres and uneven distribution of deposits with fuel and raw materials are assumed throughout.

Weber (1958) studies two kinds of variable general factors. One is called regional factors which are primary causes of the regional distribution of industries. The other is agglomerating and deglomerating factors which are secondary causes of redistribution of industries. In his theory from analysis of a given industrial process, the key regional factors are transportation costs and labor costs. He investigates the impact of transportation costs referring to the weights of localized material and product transported and the distance covered. When labor costs are kept as a constant, he finds that the location of manufacturing industries is determined by the ratio between the weight of localized material and the weight of the product. The ratio is called the material index. This means that the ratio between weight of localized material and weight of the product decides the transportation costs which determine the location of the industries. For the impact of labor costs, he points out that industries will move from a location with lowest transportation costs to a location with lower labor costs if the saving in labor costs is higher than the extra transportation costs. After the primary fixing of industries at a location with lowest regional costs, agglomerating and deglomerating factors then express their effect to causes the location of industries to change. Higher rent due to increasing concentration of industries is a key deglomerating factor. Thus land rent is here considered as the cause of changing a location.

3.3 Transportation, Accessibility and Land Value

The theory of relationship between transportation, accessibility and land value has been developed for a long time. Haig is one of the first scholars who deliver that kind of theory. Haig (1926) explains there is a friction of space to the region outside the centre of the city. The friction of space reduces the accessibility, which is the ease of contact, to the centre. Transportation is in essence a method of overcoming the friction of space although it is imperfect as it can never become instantaneous or effortless. To overcome the friction, transportation involves costs in terms of time and money. According to Haig (1926), rent is the charge which the owner of a relatively accessible site can impose because of the saving in transportation costs which the use of his site make possible. There is a complementary character between transportation costs and site rent. Thus, in his model, when an economic activity approaches the centre, site rent will increase and transportation costs will decrease, and vice versa. When transportation overcomes the friction of space, site rent and transportation costs complement to represent the social cost of the remaining of the friction. Therefore, site rent and transportation costs are termed as the costs of friction, which should be kept as low as possible in a theoretically perfect site. It is a vital contribution for Haig to state the complementary relationship between transportation costs and land rent.

Haig (1926) is also famous in stating the impact of improvement in transportation to the land rent. On this point he writes, 'An improvement in transportation, ceteris paribus will mean a reduction in friction and the diminution of the aggregate sum of site rentals.' When there is an improvement in general transportation, the relative advantage in convenience of the centre of the city over outlying districts will be reduce. This leads to a decline in the total land rent.

Ratcliff (1949) has criticized Haig's theory on transportation costs and site rent. He generally agrees with the complementary character of transportation costs and site rent. As the distance to the centre of the city increases, transportation costs increase and rent declines due to the complementary character. He also believes that the objective of each land use is to have the lowest rent and transportation costs at the same time. But this seldom happened in the real world as the site with low transportation costs usually has high rent. He explains that this phenomenon is due to the competition between land users for beneficial lands. They are willing to give higher rent to the savings in transportation costs. This explanation gives supplement to the complementary theory. However, he is confused by Haig's opinion on transportation improvement. Ratcliff (1949) argues that an improvement in transportation will reduce the costs of travelling to other places. It will benefit an area and result in higher rent in that area. Thus the aggregate sum of site rents should not be reduced. They consider the problem of transportation improvement from different points of view.

Alcaly (1976) states the close relationship between transportation costs and urban land values. Their relationship is believed to be best approached by considering the role of transportation costs in the formation of cities first. Without transportation costs, accessibility would not be important to preserve economic linkages and then the distribution of economic activities in space would be essentially uniform. Eventually, there would be no difference in land values at different location. In reality, transportation costs are in existence. The land value should be complementarily affected by transportation costs as that implied by the Haig's model. But Alcaly (1976) argues that the sum of land value and transportation costs is constant throughout the city instead of varied with the location. And the sum should be equal to the maximum annual outlay for transportation which occurs among those families living at the perimeter of the city at where the land value is equal to zero. When a site is further located from the CBD, the transportation costs increases and then the site rent decreases complementarily as shown in Figure 5.

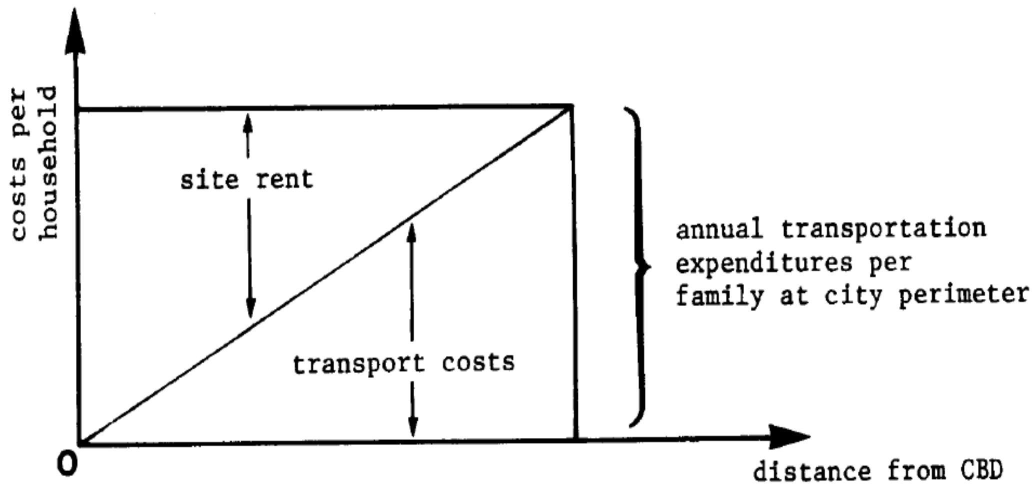

Figure 5: Graph showing complementary relationship of transportation and site rent

Source: Alcaly (1976)

Alcaly (1976) has also studied the effect of transportation improvement and again gives critiques to Haig's theory. It is a breakthrough to claim that the impact of transportation improvement to land value is based on the price elasticities of demand for transportation and land. If the elasticities of demand for both are zero, that is, the demand for transportation and land is independent of their costs, then the land value will be reduced due to a reduction in costs of friction recognized by Haig after a general transportation improvement. The rent gradient showing the site rent decreases with the distance from CBD is the negatively sloped line AB shown in Figure 6. The rent gradient after the transportation improvement is the more gentle line A'B, which indicates a reduction in land value proportional to the decline in transportation costs.

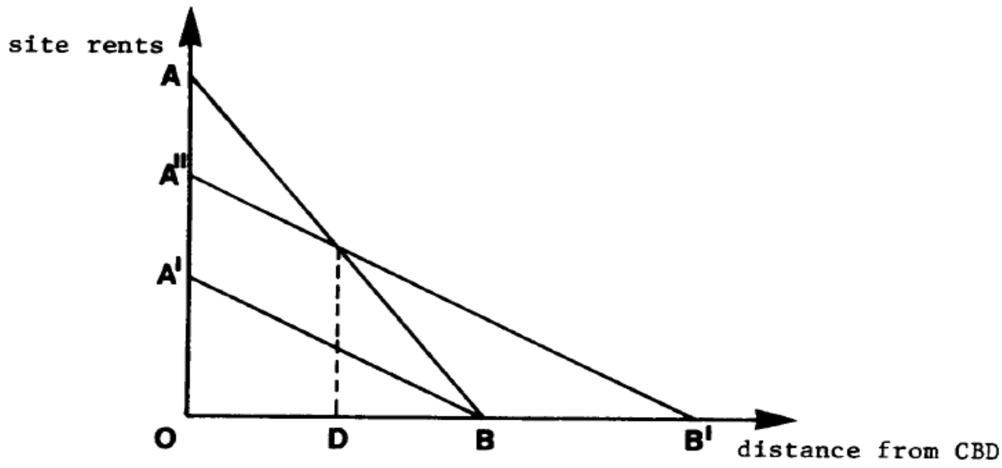

Figure 6: Graph showing the impact of transportation improvement on rent gradient

Source: Alcaly (1976)

Let's consider another situation. When the elasticities of demand for transportation and land are introduced, then the decline in transportation costs and land value will result in a rise of demand for both trips and land. By urban expansion, the area of the city will become larger than before. The line A"B' in Figure 6 shows the result of the urban expansion. Land value of a site located near the CBD and within the distance of OD will fall while those far from the central business and beyond the distance of OD will rise. Therefore, after introduction of elasticities of demand, the land values at different distance from CBD will have different results when the transportation has been improved. To capture the impact of transportation improvement on aggregate land values, as what Haig has done, another model shown in Figure 7 is used. SS and DD are the initial supply and demand curves for urban land of a city. The general improvement in transportation causes the area of the city to expand. This expansion is shown by the shifting of SS to S'S'. In case of an elastic demand curve, the aggregate land values will clearly rise as the area of A'B'C'O is larger than that of ABCO. A totally opposite result will occur if a vertical inelastic demand curve is introduced. The shifting of DD to D'D' means the increase in demand of urban land due to the rise of population. Both the land value and quantity will rise as a result.

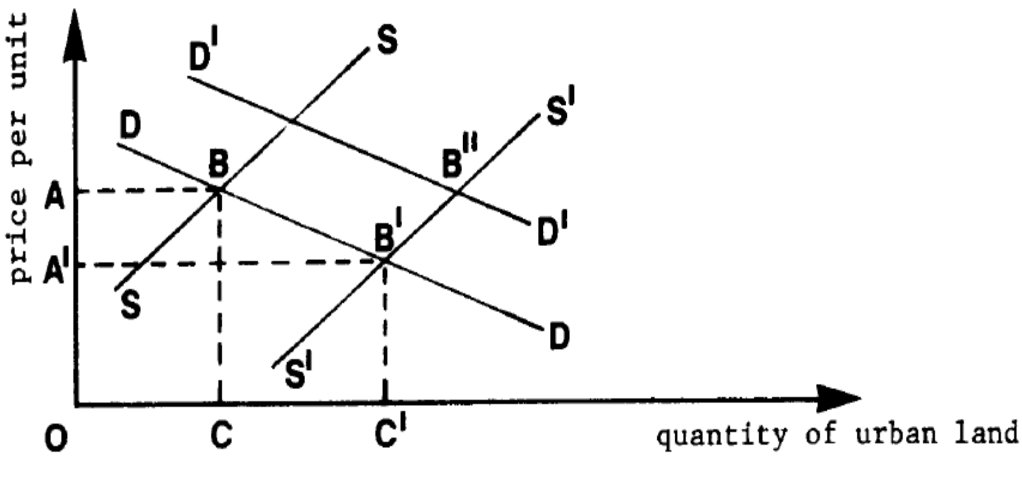

Figure 7: Graph showing impact of transportation improvement on supply and demand of urban land

Source: Alcaly (1976)

Alcaly's theories suggest that the effect of transportation improvement on an independent land value and aggregate land value also depends on the two elasticities of demand. In reality, it is impossible for the two elasticities to be zero. Thus the impact with introduction of the elasticities of demand is more likely to occur. This is contradictive with Haig's theory.

3.4 Empirical Study of Impact of Transportation Improvement

The impact of transportation improvement on residential property prices has been studied by many scholars. It was a hot topic during 1970s and 1980s. At that time, the technology of transportation developed at a high rate. This encouraged scholars to find out the effect of improved transportation to different attributes. As issues of transportation and accessibility are closely related to the land and property market in a region, some studies tried to find out how the transportation improvement exerts influences on prices of residential properties nearby. Although these studies have a common goal, but the results they found are usually different when studying different models are employed.

Damm, Lerman, Lerner-Lam and Young (1980) believe that the pattern of development and spatial distribution of urban real estate values are always affected by the provision of public infrastructure including transportation facilities and public services. The transportation improvement should influence the behaviour of both suppliers and demanders of residential and commercial properties. The improvement will lead to benefits in urban property values. U.S. government also presumes this situation and implements value capture policies to tax back the induced increases in urban property values to help finance public investment. It is important to have an empirical test on the presumption behind to criticize the policies. They use Washington D.C. Metro rail system as the model of hedonic pricing analysis and focus on the pre-implementation impact of the rail to surrounding property prices.

The distance variable plays an important role in a study of relative property prices (Richardson, Vipond and Furbey, 1974). In most of empirical house price and land value studies, distance also exerts a statistically significant impact. Therefore, Damm, Lerman, Lerner-Lam and Young consider relative prices of properties at different distance from the rail route rather than the total aggregate urban property values. In their empirical test, they find that the rail have statistically significant effect to the property prices in the pre-implementation period. The increasing distance to the rail station is associated with lower property prices and the effect of distance seems to decline quite rapidly (Damm, Lerman, Lerner-Lam and Young, 1980). The inverse relation between the distance from the location of transportation improvement and property prices is pointed out clearly. Obviously, there is a positive impact of transportation improvement to urban property prices. In addition, they also expressly show that the number of years to completion of the rail has significant influences on property prices.

The positive impact of transportation improvement can be observed in Bajic's empirical study on the effects of a new subway line in Toronto on the residential property prices. Bajic (1983) breaks the analysis into two specific parts. The first part considers the identification of direct benefits from the improvement in transportation per owner-occupant household in term of commuting costs. A modal choice model is used for the estimation of the direct benefits. The other part concerns the formulation and testing of a model to determine the impact of the new subway line on residential property prices. Hedonic price model is used in this part for the identification of the impact of the subway on residential property prices.

As the benefits from an improvement in transportation are usually reflected in the premium paid for housing, there is a need to analyze and compare the results from two different models. When the savings in commuting costs estimated from the modal choice model is compared with the rise of residential property prices in the impact area identified by hedonic price model, he finds that the direct savings from the improvement in transportation have been capitalized into housing values. In other words, the transportation improvement initiates reduction in commuting costs which is then transferred from commuters to residential property owners through complex workings of the urban housing market (Bajic, 1983). This gives an explanation to how the improvement of transportation has a positive effect on the residential property prices.

Base on Miyao's theory suggesting that future accessibility improvement can be capitalized into housing prices (Miyao, 1987), Henneberry (1998) also study the impact of transportation improvement on the residential property prices. He conducts a hedonic pricing analysis to identify effects of a new light rail system, which links the northwest and southeast of a single sub-regional urban centre in Sheffield, on nearby housing prices. Three dates are chosen for the examination of price structures: April 1988, before the decision was taken to build the light rail system but public knew a new light rail route may be probably built; April 1993, when there was wide public knowledge of the light rail system but before any substantial construction work had started; and April 1996, after construction of the light rail system was completed and it just stared operation.

In Henneberry's empirical analysis, the residential property prices inversely decline with the distance from the future route of the light rail system in the 1988 period. For the 1993 period, the situation is totally different. There is a modest direct relationship between the residential property prices and the distance from the future route of the light rail system. Then in the 1996 period, the location of residential properties in relation to the route of the light rail system has no statistically significant influence on their prices. The difference between the results for 1988 and 1993 states the fact that public has positive expectations of improvement in accessibility when they know a new light rail route may be constructed. However, expectations of disruption caused by the construction works of the light rail system oppose the case. On the completion of the light rail system, the negative impact has disappeared. The light rail system has no further impact on the housing prices. This may be due to the short period of operation. The analysis of housing prices is undertaken only four months after the full opening of the light rail system. It may take much longer time for the advantages of the light rail system to be fully appreciated by residential property owners. Thus the impact on residential property prices may become evident longer later. (Henneberry, 1998)

Henneberry's empirical analysis finds that the effects of transportation improvement are totally different in the three different periods including after announcement, during construction and during operation due to the variation of public expectations. In his empirical study, transportation improvement shows a significantly positive impact only during the period after announcement.

Voith (1991) also assents with the positive impact of transportation improvement. He uses the Census of Housing and Journey to Work data merged with transportation system data to examine residential sorting on the basis of employment location and accessibility in Philadelphia in U.S. The value of a rail connected to CBD is capitalized into residential property prices. And each household would like to pay a premium of 6.4% in average of the house price for a residential property associated with accessibility to a rail. His study gives conditions for the capitalization to exist. Voith (1991) suggests that the impact of a rail will base on whether the rail is commuting to the CBD and the attractiveness of the CBD in terms of local taxes, services and crime rate etc. This idea is also possessed by Benjamin and Sirmans (1996). Accessibility to CBD with good environment and opportunities is an important attribute to households. Households would like to pay more only for housing near available mass transportation connected to those CBD.

Chau and Ng (1998) examine the positive influence of improvement in public transportation capacity to housing market in another way. They focus on the change on the price gradient of residential properties along railway line. After the improvement, shifting of population from city centre to sub-urban areas may occur and then affect residential price gradient along a rail route. However, it is hard to deduce the actual change of residential price gradient theoretically. The large demand for housing in sub-urban areas may lead to a decline in residential price gradient while a contradictory proposition may be resulted by the higher population density and lower quality of living environment. An empirical test on that is thus required. The change of residential price gradient along KCR after rail electrification is investigated. The result supports that the transportation improvement has a negative effect on residential price gradient along a railway line. Although a significant result about the change is obtained, using small size of transaction pricing data in the empirical test leads to failure in indicating how widespread the change is. Another major finding in their study is that time is needed for the relative price levels to reach a steady state due to people’s expectation and adaptation to a change. Transaction pricing data may not reflect the impact immediately after the improvement.

Although some empirical studies show that transportation improvement can exert a positive impact to property prices, there are some other studies with totally opposite empirical results. Examples include Poon (1978), Gatzlaff and Smith (1993) and Forrest, Glenn, Grime and Ward (1996). They have a different proposition to the impact of transportation improvement.

Poon (1978) believes that railway usually produces pollution which represents a source of nuisance to many people, especially those living near the tracks, and is likely to have adverse effects on human health. The route of a new railway in London is used as the empirical study target. It is proved that residential property sale prices significantly increase with distance from the rail route. The empirical evidence presented in his study shows the capitalization of railway pollution into residential property prices.

Besides Poon (1978), Gatzlaff and Smith (1993) also show empirical evidence objecting to the positive impact of transportation improvement to property prices. They examine the impact of development of the Miami Metrorail system on residential property prices proximate to the rail station. Although the access has been improved and property use has been potentially altered by the new development of railway, there is only insignificant effect on residential property prices due to the announcement of the development of the Miami Metrorail system and proximity to the stations. It is because of the expected congestion effects followed by the rail development. Public may also expect an increased crime rate. This alters the impact of transportation improvement to proximate property prices. From Poon (1978) and Gatzlaff and Smith (1993), it is found that the externalities of a transportation improvement has affected the impact it exerting.

In 1992, a new light railway line, called Metrolink, started its operation in Manchester to solve the inadequateness of rail services within the city. Forrest, Glenn, Grime and Ward (1996) carry out a two-stage study on it. First, on the basis of a rich data set for a period before the starting of the new railway, hedonic price method is used to estimate the price differentials for properties with good access to railway stations either on Metrolink routes or on other Manchester lines. Then they use a similar data set for the period after the starting of Metrolink to see whether the price differentials have changed or not following the introduction of the new railway. The result shows a negative impact of the new railway to property prices. It is found that proximity to stations tends to lower property price in the first stage of the study. Even after starting operation of Metrolink, there is no significant improvement on prices of properties relatively near the rail stations. The negative result stands in a pointed contrast to findings stated before. The reason behind is that Metrolink is introduced into a deregulated transport environment and franchised to a private operator (Forrest, Glenn, Grime and Ward, 1996). Fare levels are higher than other rail services and the new railway only offers a revised rather than a new system. Then public's expectation on Metrolink cannot be achieved which is reflected in relative property prices. The result shows that the impact of transportation improvement is closely related to the quality of the improvement other than externalities of it. Subtractive effect on residential property prices will occur if the improvement fails to provide a better service.

Apart from suggesting the direct impact of transportation improvement to residential property prices, some studies give ideas on other issues regarding transportation improvement.

A framework for evaluating the long-run effects of a transportation improvement is developed by Stucker (1975). A model of residential location in San Francisco is manipulated to derive an estimating equation about changes in households' preferred location. In long run, the introduction of transportation improvement can attract significant numbers of new families into the regions served. The price effect initiates this situation. The change in the marginal price of location affects the households' marginal trade-offs between location and other goods and then encourage them to make a locational change (Stucker, 1975). Stucker's study gives evidence and explanation to migration activities originated from transportation improvement.

Coulson and Engle (1987) focus on different kinds of transportation costs regarding a transportation improvement. After the improvement, transportation costs should be changed and such changes will be capitalized into residential property price. Their empirical result shows that different kinds of transportation costs are under different levels of capitalization. Changes in the non-gasoline money costs are capitalized more or less correctly, while changes in time and gasoline costs are overcapitalized (Coulson and Engle, 1987). An extremely large impact of time and gasoline costs to residential property prices is observed.

3.5 Hedonic Price Model

Property prices are affected by many different factors. Relationships between property prices and those factors can be determined by various techniques. Hedonic price model is an econometric technique widely used in studying property prices to identify the relationships. It is first used for studying fixed assets by Griliches (1961).

Hedonic price model is originated from the theory of utility-bearing characteristics which is considered explicitly in studies of Becker (1965), Lancaster (1966) and Muth (1966). The theory of utility-bearing characteristics suggests that characteristics of goods bundle together to make goods can be organized into groups derived from the characteristics they contain. Then goods within groups are purchased by consumers based on the characteristics possessed. Utility is created from goods through these processes (Lancaster, 1966). As the original utility-bearing characteristic theory just emphasizes on consumer behavior and properties of market equilibrium have not been worked out, Rosen (1974) further develops the theory to state that goods do not possess final consumption attributes but rather are purchased as inputs into self-production functions for utility-bearing characteristics. Goods purchased can be valued for their utility-bearing characteristics. Thus the value of goods is a function of a bundle of characteristics. This is the basis of hedonic prices, which are conceptualized as the sum of implicit prices that the market ascribes to the various attributes contained in a bundle (Rosen, 1974).

The price of a property is hypothesized to be a function of characteristics of its structure, its lot and its neighborhood in hedonic price model (Poon, 1978). With information on prices of properties and their varying attributes, the inter-relationships between different attributes and property prices can be derived through analysis (Henneberry, 1998). In details, when applying the hedonic price model, attributes rendering structures, locations and neighborhoods of properties should be determined first. Those attributes are independent variables where property prices are dependent variables. Then regression technique is carried out in order to have a regressed linear equation. The coefficients of attributes in the regressed linear equation are reflecting the effects of attributes to property prices. If property prices increases with an attribute, the sign of the attribute is positive, and vice versa (Freeman, 1993). The significance of the impact of an attribute can also be determined by statistical tests. By this way, the extent of an attribute affecting prices of properties can be observed clearly.

Hedonic price model is particularly suitable for identification of the determinants of housing and land prices because it is able to recognize the heterogeneity of urban housing and land sites (Blackley, Follain, and Ondrich, 1984). As the property prices are affected by many different factors, the main problem of measuring the impact of a specific factor on is that many other factors in addition may be occurred. Hedonic regression analysis is an explicit method to deal with this problem. It can be used to isolate the impact of target factor from other effects efficiently. Chau and Ng (1998) also recognize this advantage of using hedonic price model. In their study of the impact of electrification of KCR, effects of other factors which may at the same time affect the price gradient are needed to be controlled. Other than selection of homogeneous samples, they use hedonic price model to control the effects of other price influencing attributes which are entered as independent variables.

Although hedonic price model possesses advantages in studies of property prices, limitations are existed when using this model. Rosen (1974) states that estimated hedonic price-characteristic functions can clearly reflect their inter-relationship but typically identify neither demand nor supply. In fact, hedonic price model cannot identify the structure of consumer preferences and producer technologies that generate them. Another limitation mentioned by Rosen (1974) is that hedonic price model reflects just the highest successful bid for a property and does not accurately measure one's valuation of the property. The values of properties estimated by the model are tended to be over-stated. Also, Chau and Ng (1998) mention that when estimating the equation of the hedonic price model, there is requirement of a reasonably large number of observations. The amount of data required ought to be very substantial if there are a large number of independent variables or non-linear specification is more suitable for a test.

Hedonic price model also receives criticism from other scholars. Linneman (1982), emphasizes that the model itself have not given a general basis for the selection of variables. The model requires a large amount of information of properties but there are general rules telling what independent variables should be involved and how the equation for the model is set up. Dunes and Jones (1998) claim that hedonic prices are assumed to be equalized throughout markets and property types when using the hedonic price model. However, the situation in real world is totally different. When combining with other attributes, different attributes will be valued diversely. This leads to different hedonic prices in different markets and property types. The hedonic price model is thus reflecting something contradicting real situation.

CHAPTER 4: RESEARCH METHODOLOGY

4.1 Introduction

The methods used for empirical tests are hedonic price model and unpaired t-test. Particular variables are adopted for the hedonic price model in this study. The variables include both dependent and independent variables. In order to operate a hedonic price model, a regression equation consisting different variables must be set and a large amount of data must be collected. The details of regression equation and data collection are also stated in this chapter.

4.2 Hypothesis

This study aims at finding out the effects of railway extensions on railway residential property prices in Hong Kong. Railway extension is considered as a kind of transportation improvement. It is no doubt that an improvement in transportation will be capitalized into residential property prices due to the reduction in transportation costs (Miyao, 1987). However, the actual impact on housing prices is varied with cases as externalities and quality of a transportation improvement can be additionally capitalized into housing prices. Poon (1978), Gatzlaff and Smith (1993), and Forrest, Glenn, Grime and Ward (1996) claim that residential property prices may suffer negative influences by transportation improvement which induces problems of pollution, congestion or higher crime rate. Therefore, railway extensions in various cases would affect residential property prices along the railway line in different ways.

The change in price gradient reflects the impact of railway extension on residential property prices along railway line. The relationship between property values and distance from the centre of a city is indicated by the price gradient. Referring to Haig (1926), values of properties at the centre of a city stay at the relatively highest level. The values then decrease with the distance from the centre of the city. The price gradient thus is negatively sloped and steeper at the centre than at the fringes of the urban area. It shows the price difference between properties near city centre and those at a longer distance.

The relative advantage of accessibility in a region closer to the CBD leads to higher property values in that region (Alcaly, 1976). A transportation improvement, such as an extension of railway, should help to diminish the relative advantage in the region closer to the CBD. As a result, the difference between housing prices at various distances from the CBD should be reduced. Therefore, it is believed that railway extensions ought to cause a decline in price gradient of residential properties along the railway line. Hence, the first hypothesis to be tested in this study is:

A railway extension will lead to a decline in the price gradient of railway residential properties.

In order to test the first hypothesis, the transaction data of railway residential units in two different stations along a railway line before and after a railway extension is analyzed by the hedonic pricing model. There should be an interactive independent variable representing the price difference of railway residential properties in the two stations. If the coefficient of the variable is negative and statistically significant, the railway extension has reduced the price gradient. Then the first hypothesis cannot be refuted.

The accessibility to the CBD is an extremely important attribute to housing prices. Households always concern the transportation costs to the employment and business centre rather than that of other areas (Voith, 1991). If a transportation improvement is adopted to enhance the accessibility to the CBD directly, households in a remote region will be able to access the central market with lower costs in terms of time and money. Therefore, the relative advantage of accessibility in the region closer to the CBD should be reduced which means the slope of the housing price gradient would also be reduced.

On the other hand, when considering an improvement of transportation to a non-CBD district, the impact on the housing price gradient may be different. It is because households in the remote region can only save the transportation costs to a non-CBD district but not that to the employment and business centre. Hence the housing price gradient is believed to be reduced in a lower extent when a railway is extended to a non-CBD district. Hence the second hypothesis is:

A railway extension to the CBD will lead to a greater decline in the price gradient of railway residential properties than that to a non-CBD district.

In order to examine the second hypothesis, a hedonic price model testing the change of the price gradient of railway residential properties by a railway extension to the CBD and that to a non-CBD district should be established. The coefficients reflecting the extent of changes in price gradients in the two models are compared. The second hypothesis cannot be refuted if three conditions occur. Firstly, the coefficients in the two models are negative and significant. Secondly, the coefficient in the model of CBD extension has a higher magnitude. Thirdly, the difference between the coefficients is statistically significant.

4.3 Subjected Target of Study

4.3.1 Subjected Railway

East Rail Line of the Mass Transit Railway Corporation (MTRC) is the subjected target in this study. There are altogether fifteen stations along East Rail Line. Out of these stations, East Tsim Sha Tsui Station and Lok Ma Chau Station are the main focus.

There are reasons behind the choice. Firstly, Tsim Sha Tsui Station and Lok Ma Chau Station are recent extensions of East Rail Line. The effects of them to property market have not been studied by previous scholars. Secondly, the Tsim Sha Tsui Station is located in the CBD in Kowloon while Lok Ma Chau Station is sited in a non-urban area where is regarded as a non-CBD district. They represent extensions of railway to regions of different natures. The difference between their effects on the price gradient of railway residential properties is obtained to examine the second hypothesis.

East Tsim Sha Tsui Station is the southern terminus of East Rail Line. It is extended from Hung Hom to Tsim Sha Tsui through a tunnel beneath Salisbury Road. It is the only underground station along East Rail Line. Surface traffic jams and passenger congestion at Kowloon Tong Station are reduced by operation of East Tsim Sha Tsui Station. East Tsim Sha Tsui extension is used to set up the model of CBD extension.

Lok Ma Chau Station serves as the northwest terminus of East Rail Line. It is extended from Sheung Shui and located in the Frontier Closed Area in Lok Ma Chau. Being a branch station to serve passengers travelling between Hong Kong and mainland China, it alleviates the overcrowded situation at Lo Wu Station. It also connects to Shenzhen Metro through immigration control points. Lok Ma Chau extension is adopted for the model of non-CBD extension.

The study is going to find out the change of the price gradient after operation of the two railway extensions. The operation dates of East Tsim Sha Tsui station and Lok Ma Chau station are listed below:

	East Tsim Sha Tsui Station	**Lok Ma Chau Station**
Operation Date	24th October, 2004	15th August, 2007

Table 2: Operation date of two new railway extensions

Source: MTR Corporation (2009)

4.3.2 Subjected Railway Residential Properties

There are numerous residential properties lining along East Rail Line to obtain transportation benefits. Some of them are chosen for the study. The selection of residential estates for the study bases on several criteria.

The first criterion is that the distance between residential estates selected and the nearest railway station should be within 100m. The estates ought to be located approximately five minutes walk from the respective station. They are defined as railway residential properties in this study. The second criterion is that the estates should be private residential properties with similar building height and facilities. This can help to reduce the heterogeneous nature of residential properties. The third criterion is that there should be flourish transaction activities in the estates before and after the operation date of the respective railway extension in order to collect enough transaction data for empirical tests.

Four private residential estates closed to four different stations of East Rail Line are selected under the above criteria. They are Royal Peninsula, Grandeur Garden, Uptown Plaza and Sheung Shui Town Centre. Their locations are shown in Appendix 1. Table 3 summarizes their details:

	Royal Peninsula	**Grandeur Garden**	**Uptown Plaza**	**Sheung Shui Town Centre**
Station Nearby	Hung Hom Station	Tai Wai Station	Tai Po Market Station	Sheung Shui Station
OP Date	14/12/2000	25/6/1985	4/4/1991	18/8/1992
Facilities	Carpark, swimming pool, sport courts, garden	Carpark, swimming pool, sport courts, garden	Carpark, swimming pool, sport courts, garden	Carpark, swimming pool, sport courts, garden

Table 3: Relevant details of targeted railway residential properties

Source: Centaline Property Agency Limited (2009)

Transaction data of Royal Peninsula and Grandeur Garden is used to study the impact of East Tsim Sha Tsui extension on the housing price gradient along railway while that of Uptown Plaza and Sheung Shui Town Centre is used to determine the change in the housing price gradient along railway due to Lok Ma Chau extension.

4.4 Method for Empirical Test

Different methods have been applied by former scholars to study the effects of various factors on property prices. Hedonic price model is the most popular method used in those studies. It is also the key method used in this study to examine the hypotheses. Apart from hedonic price model, unpaired t-test is also applied to associate the examination of the second hypothesis. It can determine whether the difference between coefficients from two models is statistically significant or not.

4.4.1 Hedonic Price Model

4.4.1.1 Suitability

Residential properties have a heterogeneous nature. Their prices are affected by a large number of characteristics. This gives restrictions on determining the impact of a particular factor on residential property prices. In order to test the hypotheses in this study, hedonic price model is adopted to solve the problem of heterogeneous nature of residential properties. It is an efficacious method in controlling the effects of other price influencing characteristics (Chau and Ng, 1998). It gives an explanation to prices of properties in terms of their characteristics including location, floor, age, facilities, view, accessibility, neighborhood, etc. It is assumed that each of their characteristics is implicitly priced (Rosen, 1974).

In the literature review, some limitations to hedonic price model are stated. One of the limitations is that hedonic price model does not consider the supply and demand functions. However, this limitation can be neglected in this study because this study is going to determine the impact of the transportation improvement on housing prices but not the supply or demand functions.

Hedonic price model is also limited at giving an accurate account for one’s valuation of properties as it only states the highest successful bid for properties. A bid for a property is the amount of money willing to be paid for the property by someone. It represents a possible value of the property. The highest bid for a property should be able to give accurate valuation to the property accurately.

Another limitation is that there is a requirement of a reasonably large number of observations for hedonic price model. This limitation is not a problem in this study because the transaction activities in the primary and secondary residential property market are very flourish. A large amount of transaction data of residential properties of the selected estates is available.

4.4.1.2 Functional Form

The hedonic price is the sum of implicit prices of a series of attributes. It can be expressed as the equation, P = f (L, S, N)…, where L, S and N are different price influencing attributes (Mok, Chan and Cho, 1995). The equation of hedonic price model has various functional forms. Beside linear form, there are alternative forms such as polynomial form, logarithmic form and semi-logarithmic form. In order to estimate the relationship between property prices and different attributes accurately, selection of a suitable functional form is crucial (Linneman, 1980).

When studying housing prices, linear form and semi-logarithmic form are usually applied. Hedonic equations for the linear form and semi-logarithmic form are listed as followings:

Linear form:

$$P = C_0 + \sum_{i=1}^{n} C_i X_i + e$$

Semi-logarithmic form:

$$\text{Log } P = C_0 + \sum_{i=1}^{n} C_i X_i + e$$

where P = housing price (dependent variable)

C_0 = constant term

C_i = coefficients

X_i = attributes (independent variables)

e = error term

There is no any guidance set by hedonic price model for the selection of a correct functional form. However, the significance of a correct functional form should not be ignored. Butler (1982) states some criteria about the selection of a suitable functional form for an empirical test including plausibility, goodness of fit, and the like.

Other scholars have different opinions on the selection of functional forms. Some of them suggested that the linear form should be adopted as the first attempt. When the linear form fails to obtain an accurate result, then other functional forms should be tried to until a sufficiently precise estimate occurs. Gordon and Richardson (1982) agree with this idea. They found that linear form is an efficient form. There is no clear evidence that the linear form is inferior to other forms with higher complexity.

There is no general rule for the selection of a suitable functional form. Different scholars have different ideas about that. It is believed that each particular model should have its appropriate functional form respectively. In this study, the semi-logarithmic form is applied to examine the hypotheses. Coefficients in the semi-logarithmic form are able to identify the percentage change of the housing price due to a unit increase in respective attributes. The form is chosen due to the ease for interpretation. It is also the most common form used to provide the best fit estimate (Galster and Williams, 1994).

4.4.1.3 Interpretation of Statistics

After entering the transaction data for hedonic regression, statistics will be generated for further analysis and interpretation. The results include coefficients of independent variables, a coefficient of determination, t-statistics and a F-statistic, etc.

Coefficient (C_i)

A coefficient measures the magnitude of variation of the dependent variable due to a unit change of an independent variable. There is a positive or negative sign associated with a coefficient. The positive sign of a coefficient shows that the dependent variable will rise due to a unit increase in the respective independent variable, and vice verse. Thus, a coefficient implies not only the extent of the dependent variable changed, but also whether the dependent variable is positively or negatively affected by an independent variable.

In the linear functional form, a coefficient is equal to the actual value change in the housing price per unit increase in an attribute. However, the semi-logarithmic functional form is used in this study. A coefficient in the form implies the percentage change instead of the actual value change of the housing price.

Coefficient of Determination (R-squared)

The coefficient of determination demonstrates the proportion of variation in the dependent variable which can be justified by variation in the independent variables. In other words, it shows the explanatory power or goodness of fit of a hedonic price model. The coefficient of determination is in a square form so as to measure the absolute strength of the correlation between the dependent variable and independent variables in the same model without indicating the direction (Korn and Simon, 1991). The value of the coefficient is ranging from 0 to +1. When it equals +1, there is a perfect correlation between the dependent variable and independent variables. While its value reaches 0, the dependent variable and independent variables are not correlated. There is an adjusted coefficient of determination in addition to the coefficient of determination. Apart from independent variables, the adjusted coefficient of determination also considers the sample size.

For example, if both the coefficient of determination and the adjusted one of a model are about 0.85, the dependent variable and independent variables are highly correlated and the sample size is sufficiently large. It shows that 85% of variation in the dependent variable is due to variation in the independent variables included in the model. The remaining 15% cannot be justified by the independent variables.

t-statistic

A t-statistic is an indicator for an independent variable to determine whether it is statistically significant to the change of the dependent variable or not. Cheung (2004) mentions that it is a relative measure of the average impact of an independent variable exerts on the dependent variable while comparing to the degree of variability of the factor in the sample. A t-statistic can be calculated by subtracting the hypothesized value from the statistical estimate which is then divided by the estimated standard. Usually, the hypothesized value is equal to zero. A t-statistic is calculated by:

$$t = b_i / Sb_i$$

where t = t-statistic

b_i = statistical estimate

Sb_i = estimated standard error

Generally, a larger value of t-statistic means that the value of the coefficient b_i is more likely to be different from zero. Thus the impact of the respective independent variable to the dependent variable is more significant and the estimate is more accurate.

In order to test the degree of significance of an independent variable, simple t-test is carried out. When a t-statistic is generated, it will be compared with a critical value of t in the t-distribution table. The critical value is selected on the basis of a decided significance level and degree of freedom, which is determined by the size of samples and independent variables. For a particular significance level and degree of freedom, there is a respective critical value of t in the t-distribution table. If the value of the t-statistic is larger than the respective critical value of t, the impact of the independent variable to the dependent variable is statistically significance at that significance level.

The reliability of each attribute in the hedonic price model on the housing price can be defined by a t-statistic. It is extremely crucial for the interpretation of an attribute. If the t-statistic shows the respective attribute is statistically insignificant, the effect of that attribute on the housing price is neglectable.

F-statistic

The F-statistic is used to indicate whether a regression model is statistically significant or not. It takes into account of all independent variables in a model but not only one of them. It measures and compares generalized sum of squares of t-statistics to examine the probability of statistical coefficients being zero (Christensen, 2003). Therefore, when a model contains only one independent variable, the F-statistic becomes the square of the t-statistic in that model.

Similar to the analysis of the t-statistic, the F-statistic of a model should be compared with a relevant critical value of F in the F-distribution table. The critical value of F is decided by a particular significance level and degree of freedom. If the value of the F-statistic is higher than the respective critical value of F, the model of hedonic is statistically significant. A higher value of the F-statistic implies that the independent variables included in the model are more significant and more powerful in explaining the change of the dependent variable.

4.4.2 Unpaired t-test

4.4.2.1 Suitability

In order to test the second hypothesis, the coefficient reflecting the extent of change in the price gradients in the model of CBD extension is compared with that of the non-CBD district extension. As the coefficients come from two independent models with different sample sizes and subjected targets, they cannot be simply compared by stating the difference between their values only. Therefore, unpaired t-test is applied to determine whether the difference between them is statistically significant or not.

The unpaired t-test is also called t-test for two independent samples, which is a parametric statistical test employed in a situation with two independent samples. It is used to state the significance of the difference between two independent sample means. The test is based on the t-distribution and operated similar to a simple t-test for single sample (Sheskin 2000).

4.4.2.2 Interpretation

There are three assumptions behind the unpaired t-test. Firstly, each sample has been randomly selected from the population it represents. Secondly, the distribution of data in the underlying population from which each of the samples is derived is normal. Thirdly, the variances of the underlying populations represented by the two independent samples are homogeneous (Sheskin 2000).

When carrying out the unpaired t-test, null and alternative hypotheses should be set up first. The alternative hypothesis is usually based on the subject to be tested while the null hypothesis is often talking about the subject aimed to be rejected. The nature of alternative hypothesis determines whether the test is one-tailed or two-tailed. If the alternative hypothesis is directional, it should be evaluated with a critical one-tailed test. However, two-tailed test should be adopted if the alternative hypothesis is non-directional. Then the t-statistic regarding the difference between sample means is calculated by the general equation for unpaired t-test. The general equation for both equal and unequal sample sizes is:

$$t=\frac{\overline{X}_1-\overline{X}_2}{\sqrt{\left[\frac{(n_1-1)\tilde{s}_1^2+(n_2-1)\tilde{s}_2^2}{n_1+n_2-2}\right]\left[\frac{1}{n_1}+\frac{1}{n_2}\right]}}$$

where t = t-statistic

$\overline{X}_1$ = sample mean of sample 1

$\overline{X}_2$ = sample mean of sample 2

$\tilde{S}_1$ = standard deviation of sample 1

$\tilde{S}_2$ = standard deviation of sample 2

n_1 = sample size of sample 1

n_2 = sample size of sample 2

After estimating the t-statistic, the degree of freedom is determined. It is calculated by the sum of sample size minus 2.

A preferred significance level should also be selected. It is usually 1% or 5%. The t-statistic calculated is then compared with the respective critical value determined by the selected significance level and the degree of freedom in the t-distribution table. In order to reject the null hypothesis and support the alternative hypothesis, the absolute value of t-statistic must be equal to or greater than the specified critical value. Hence, the significance of the difference between two sample means can be proved.

In the case of this study, whether the subjected coefficient in the model of CBD extension is significantly larger than that in the model of non-CBD district extension is the subject to be tested. The null and alternative hypotheses are hence set as below:

Null hypothesis: Cc $\leqq$ Cn

Alternative hypothesis: Cc > Cn

where Cc = subjected coefficient in the model of CBD extension

Cn = subjected coefficient in the model of non-CBD district extension

As the alternative hypothesis is directional, it should be evaluated by one-tailed test. The t-statistic regarding the difference between two coefficients is calculated by the general equation as below:

$$t = \frac{C_c - C_n}{\sqrt{\left[\frac{(n_c - 1)SE_c^2 + (n_n - 1)SE_n^2}{n_c + n_n - 2}\right]\left[\frac{1}{n_c} + \frac{1}{n_n}\right]}}$$

where t = t-statistic

Cc = subjected coefficient in the model of CBD extension

Cn = subjected coefficient in the model of non-CBD district extension

SEc = standard error of Cc

SEn = standard error of Cn

n_c = sample size in the model of CBD extension

n_n = sample size in the model of non-CBD district extension

The 1% significance level is selected in this study. If the absolute value of t-statistic is equal to or larger than the critical one-tailed value at the 1% level and the respective degree of freedom, then the difference between the coefficients in the two models is statistically significant.

4.5 Variable

Butler (1982) mentions that a hedonic function should include all housing attributes that are costly to produce and yield utility to residents. Hence the housing attributes are usually location traits, such as access to economic and social facilities, structural traits, such as descriptors of the building, and neighborhood traits, such as quality of the neighborhood (Mok, Chan and Cho, 1995). Rosen (1974) also suggests that all attributes that could determine the market price of good, generating utilities to users and costly to produce should be included as independent variables in the hedonic pricing model.

Undoubtedly, the predictability of the hedonic price model can be enhanced by take into consideration of more relevant independent variables. Nevertheless, larger number of independent variables implies the requirement of relatively substantial data for estimating the regression equation (Chau and Ng, 1998). The model becomes much more complex. Chan (2002) points out a solution for controlling virtually unlimited number of independent variables for the model. Only highly appropriate and significant independent variables are applied while others should be neglected. This can help to avoid building up the hedonic price model with high level of complexity but a certain level of accuracy is preserved.

The dependent variable in the models of this study is the price of railway residential property. The independent variables are selected on the basis of appropriateness and significance. They include structural, locational and time attributes and are further classified as continuous independent variables, dummy independent variables and interactive variables.

4.5.1 Dependent Variable

Price of Railway Residential Property (PRICE)

In the models of this study, the railway residential property price is the unique dependent variable. It originates from transaction prices of railway residential properties. The problem is that transactions of railway residential properties are recorded on different date. The housing market situation changes continuously with time. Effects of inflation and fluctuation are exerted on prices. The variation in prices may due to different time base of transactions but not the effects of attributes. Therefore, to eliminate the impact of time on the models, all transaction prices are converted to be real prices which have the same time base.

To obtain real prices with the same time base, transaction prices of targeted railway residential properties from the Economic Property Research Centre (EPRC) ought to be deflated by the residential price indices. The residential price indices can be found from the Hong Kong Property Review published by the Rating and Valuation Department. Originally, the residential price indices are used for measuring changes of selling prices of residential properties with quality being kept as constant. The Rating and Valuation Department chooses a base year for comparison. The base year of latest version of the indices is 1999. So that transaction prices obtained are converted in to real prices on the time base of 1999.

There are residential price indices estimated on yearly, quarterly, and monthly basis. To maximize the accuracy of the study, the indices on monthly basis is used to calculate real prices. They are shown in Appendix 2.

4.5.2 Independent Variable

4.5.2.1 Continuous Independent Variable

Continuous independent variables are those can be quantified. The values of them can be applied directly in hedonic price model. Floor level, building age and building size are the continuous independent variables used in this study.

Floor Level (FLOOR)

The buildings in Hong Kong are usually high rise because of limited space for development. A higher floor level of a residential property is more likely to have a better view. On the other hand, the amenity of a residential property increases with the floor level as noise and air pollution generated from ground level cannot reach upper floors. By these reasons, prices of residential properties are generally increased with the floor level.

The floor level of a railway residential property can be found from the EPRC. There are some transaction records of combined units in different floor levels. Those records are eliminated as they fail to reflect the impact of the floor level on the housing price normally.

Building Size (GFA)

The building size is one of the key attributes affecting the price of a residential property. Obviously, a residential property with a larger building size is more expensive than that with a smaller building size. However, the housing price and the building size are not directly proportional. Lusht (1997) finds that there is a non-linear relationship between the building size and the building value. When the building size increases, the value increases with a reducing slope.

The building size applied in the models is in terms of gross floor area. Apart from the building area within a unit, gross floor area additionally takes into account of the building area of common areas. The above definition is used because it can determine the total area enjoyed by the owner of a railway residential property. Gross floor area of a railway residential property can be obtained directly from the EPRC. Some transaction records without listing out the gross floor area are rejected.

Building Age (AGE)

The building age of a residential property acts as an implicit indicator to the condition of the property. All existing buildings undergo deterioration continuously. When the building age of a residential property rises, unless renovation is carried out, the appearance and internal condition of the property deteriorate and the property price will be reduced.

The building age of a railway residential property is on yearly basis. It measures the period between the date of issuing Occupation Permit, which represents the birth of the property, and the date of transaction. The date of issuing Occupation Permit and the date of transaction can be found from the EPRC.

4.5.2.2 Dummy Independent Variable

Dummy independent variables are those take either a value of 1 or 0 to represent some qualitative aspects. In this study, sea view, region closer to CBD and railway extension are the dummy independent variables.

Sea View (SEAVIEW)

This dummy refers to whether a railway residential property has the scenery of sea or not. Mok, Chan and Cho (1995) mentions that the coefficients of sea view is positively related to the housing price. Because of the feeling of open and spacious, a residential unit with sea view is generally more preferable.

There is no publication stating which properties have the sea view. The information of sea view is obtained by consulting Centaline Property Agency Limited and shown in Appendix 3. In this study, a railway residential property with sea view takes the value of 1. Otherwise, the value of 0 is taken.

Region Closer to CBD (RCC)

This is a locational dummy variable used to classify whether a railway residential property is located in the region closer to the CBD or not. The CBD is the business and employment centre of a city. People would like to pay a premium for staying closer to the CBD. Housing prices in the region closer to the CBD is believed to be higher.

In this study, Hong Hom is compared with Tai Wai while Tai Po Market is compared with Sheung Shui. Hung Hom and Tai Po Market are recognized as regions closer to CBD. The railway residential properties located in Hung Hom and Tai Po Market take the value of 1. Otherwise, they take the value of 0.

Railway Extension (RE)

This is a time dummy variable used to justify whether a railway residential property is transacted before or after the date of operation of a railway extension. It is important to this study but it does not exist individually in the models. It is used to form an interactive term to examine the change in the price gradient.

For railway residential properties transacted after the operation date of a new extension, the value for the dummy variable is 1. Otherwise, the value is equal to 0.

4.5.2.3 Interactive Independent Variable

Interactive independent variable is the product of two or more independent variables. They are integrated together to indicate a correlated implication. The interaction of

Region Closer to CBD and Railway Extension is the interactive variable in this study.

Interaction of Region Closer to CBD and Railway Extension (RE*RCC)

This interactive independent variable is the product of dummy variables which are Region Closer to CBD and Railway Extension. It is the vital independent variable for testing the change in price gradient. It implies whether the public has changed their preference to purchase railway residential properties in the regions apart from the CBD, which are Tai Wai and Sheung Shui in the study, over those in the regions closer to the CBD after a railway extension.

The impact of a railway extension on the price gradient of railway residential properties can be obtained directly by analyzing the coefficient of the interactive variable. If the coefficient is negative and statistically significant, then the price gradient is reduced by the railway extension, and vice versa. The magnitude of the coefficient also gives the extent of variation of the price gradient.

4.6 Regression Equation

After consideration of the appropriate functional form and variables to be adopted in the models, the regression equation for this study is constructed.

The regression equation is:

$$\text{Log (PRICE)} = C_0 + C_1(\text{FLOOR}) + C_2(\text{GFA}) + C_3(\text{AGE}) + C_4(\text{SEAVIEW}) + C_5(\text{RCC}) + C_6(\text{RE*RCC})$$

where, PRICE = price of railway residential property

FLOOR = floor level

GFA = building size

AGE = building age

SEAVIEW = sea view

RCC = region closer to the CBD

RE*RCC = interaction of railway extension and region closer to the CBD

C_i = coefficients of independent variables

To test the hypotheses, the two models study the change in the price gradient due to two different railway extensions are examined by the same regression equation.

Referring to the previous section, the floor level and building size generally exert a positive effect on housing price. The price of railway residential property should rise with them. So the coefficients of floor level and building size are expected to have positive signs.

People usually like to pay a premium to purchase a residential property with sea view or located in a region near the CBD. The variables of sea view and region closer to CBD should also affect the price of railway residential property positively. Their signs of coefficients are also expected to be positive.

A residential property deteriorates with time. Its price will be lower when it has a higher building age. The sign of coefficient of the building age should be negative. The interaction of railway extension and region closer to the CBD is the key variable representing the change in price gradient. It is believed that the housing price gradient along railway is reduced by a railway extension. The expected sign of coefficient of this interactive independent variable is thus negative. Expected coefficient signs of all independent variables in both models are summarized in the following table:

Independent Variable	Expected Sign of Coefficient
FLOOR	Positive
GFA	Positive
AGE	Negative
SEAVIEW	Positive
RCC	Positive
RE*RCC	Negative

Table 4: Expected signs of coefficients of independent variables

4.7 Data Collection

In this study, four railway residential estates, which are Royal Peninsula near Hung Hom Station, Grandeur Garden near Tai Wai Station, Uptown Plaza near Tai Po Market Station and Sheung Shui Town Centre near Sheung Shui Station, are selected to set up two models for finding the change in the price gradient by East Tsim Sha Tsui and Lok Ma Chau extensions. A large amount of transaction records of the four estates is required. The number of transaction records used is listed below:

Railway residential Estate	Number of Transaction Record
Royal Peninsula	2366
Grandeur Garden	1054
Uptown Plaza	1326
Sheung Shui Town Centre	1243
Total	5989

Table 5: Number of transaction records used

4.7.1 Source of Data

The transaction records of targeted railway residential properties are obtained from the EPRC. The transaction price of a railway residential property, data of transaction and date of issuing Occupation Permit for estimating the building age, the floor level and the building size are found from the EPRC. The transaction records from 1996 to 2008 are collected and used as the EPRC can only provide the records within this period.

From the publications of Rating and Valuation Department, the residential price indices from 1996 to 2008 are available. They are used to deflate the transaction prices which are then converted to real prices used in the models.

It is difficult to determine whether a unit has sea view or not. There are no publication and official source indicating the existence of sea view. Therefore, electronic map is checked and phone interview to Centaline Property Agency Limited is carried out.

4.7.2 Unit of Data

Different types of quantitative transaction date collected and used in the study are measured in different units. Their units are listed in Table 6:

Type of Quantitative Data	**Unit**
Price of railway residential property	Million Dollar
Floor level	Storey
Building size	Meter Square
Building age	Year

Table 6: Units of different types of quantitative transaction data

CHAPTER 5: EMPIRICAL RESULT AND ANALYSIS

5.1 Introduction

The empirical results of the model of East Tsim Sha Tsui extension and the model of Lok Ma Chau extension are explained in this chapter. The coefficients of independent variables in the empirical results are analyzed. They represent how various attributes affect the price of railway residential property. The interactive independent variable is the most important variable in this study. It indicates the change of the price gradient of rail residential properties after a railway extension.

5.2 Empirical Result

After processing transaction records of selected railway residential properties from 1996 to 2008 by the regression equation, the empirical results of the two regressions models, which include the model of East Tsim Sha Tsui extension and the model of Lok Ma Chau extension, are obtained and shown in Table 7 and Table 9.

Chau and Ng (1998) state that time is required for the relative price levels to reach a steady state due to people's expectation and adaptation to the change in a transportation system. Capturing a discrete change exactly after the operation date cannot precisely indicate the impact of a transportation improvement. This problem is suggested to be catered by eliminating transaction records in a particular period after the operation date. In this study, to have more accurate empirical results, the two models are estimated again without the transaction data in the first 3 months after the respective operation date. It is assumed that the impact of the railway extensions would have been fully reflected after the first 3 months of operation. The modified empirical results of the two models are shown in Table 8 and Table 10

5.2.1 Model of East Tsim Sha Tsui Extension

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C0(##)	-0.124424	0.018139	-6.859620	0.0000
FLOOR(##)	0.002825	0.000284	9.963802	0.0000
GFA(##)	0.001081	1.12E-05	96.61517	0.0000
AGE(##)	-0.003373	0.000987	-3.822378	0.0001
SEAVIEW(##)	0.112165	0.007710	14.54800	0.0000
RCC(##)	0.583502	0.016976	34.37166	0.0000
RE*RCC(##)	-0.029868	0.007474	-3.996308	0.0001
Time period of data		1996-2008		
Included observations		3420		
R-squared		0.947543		
Adjusted R-squared		0.947450		
F-statistic		10274.88		
Prob (F-statistic)		0.000000		
(##): Statistically significant at 1% level (#): Statistically significant at 5% level				

Table 7: Empirical results of the model of East Tsim Sha Tsui extension

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C0(##)	-0.132036	0.018157	-7.271751	0.0000
FLOOR(##)	0.002910	0.000286	10.16498	0.0000
GFA(##)	0.001078	1.13E-05	95.50814	0.0000
AGE(##)	-0.003337	0.000990	-3.372077	0.0008
SEAVIEW(##)	0.110640	0.007803	14.17986	0.0000
RCC(##)	0.591935	0.017018	34.78359	0.0000
RE*RCC(##)	-0.038164	0.007622	-5.006811	0.0000
Time period of data		1996-2008 (exempting 24/10/2004 - 24/1/2005)		
Included observations		3344		
R-squared		0.948045		
Adjusted R-squared		0.947951		
F-statistic		10148.55		
Prob (F-statistic)		0.000000		
(##): Statistically significant at 1% level		*(#): Statistically significant at 5% level*		

Table 8: Modified empirical results of the model of East Tsim Sha Tsui extension without data in the first 3 months after operation

In both empirical results of the model of East Tsim Sha Tsui extension with and without transaction records in the first 3 months after operation, the R-squared and the adjusted R-squared are about 0.95. The R-squared and adjusted R-squared are demonstrating the proportion of variation in the dependent variable which can be justified by variation in independent variables. Therefore, 95% of the change of the price of real residential property is due to the change in independent variables adopted. The functional form and independent variables selected are appropriate. The high value of adjusted R-squared indicates that the sample size is sufficiently large.

The F-statistic of the model in both results is higher than 10000 and the p-value of F-statistic is 0. This means that the probability of the coefficients of all independent variables to be zero is equal to 0%. The regression model is proved to be significant.

When looking at the t-statistics of different independent variables in both results, their p-values show that every independent variable in the model is statistically significant to the change in the dependent variable at the 1% level. In general, the whole regression model of East Tsim Sha Tsui extension and the impact of every independent variable included are also significant and reliable.

5.2.2 Model of Lok Ma Chau Extension

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C0(##)	-0.619775	0.029141	-21.26805	0.0000
FLOOR(##)	0.004702	0.000393	11.95649	0.0000
GFA(##)	0.001890	5.04E-05	37.49798	0.0000
AGE(##)	-0.011473	0.000751	-15.27962	0.0000
SEAVIEW(##)	0.118030	0.015634	7.549370	0.0000
RCC(##)	0.315991	0.007049	44.82925	0.0000
RE*RCC(#)	-0.028618	0.013770	-2.078307	0.0378
Time period of data		1996-2008		
Included observations		2569		
R-squared		0.776292		
Adjusted R-squared		0.775768		
F-statistic		1481.736		
Prob (F-statistic)		0.000000		
(##): Statistically significant at 1% level		*(#): Statistically significant at 5% level*		

Table 9: Empirical results of the model of Lok Ma Chau extension

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C0(##)	-0.614418	0.029653	-20.72005	0.0000
FLOOR(##)	0.004810	0.000401	11.99624	0.0000
GFA(##)	0.001872	5.14E-05	36.43207	0.0000
AGE(##)	-0.010765	0.000771	-13.96824	0.0000
SEAVIEW(##)	0.118104	0.015748	7.499562	0.0000
RCC(##)	0.313509	0.007152	43.83248	0.0000
RE*RCC(#)	-0.039999	0.015634	-2.558474	0.0106
Time period of data		1996-2008 (exempting 15/8/2007 – 15/11/2007)		
Included observations		2498		
R-squared		0.771303		
Adjusted R-squared		0.770752		
F-statistic		1400.187		
Prob (F-statistic)		0.000000		
(##): Statistically significant at 1% level (#): Statistically significant at 5% level				

Table 10: Modified empirical results of the model of Lok Ma Chau extension without data in the first 3 months after operation

In both empirical results of the model of the Lok Ma Chau extension with and without transaction data in the first 3 months after operation, the R-squared and adjusted R-squared also have satisfactory values about 0.77, which is lower than that of the East Tsim Sha Tsui extension. This means that 77% of the change in the price of railway residential property is able to be explained by the change in independent variables. The sample size of the model is 2569, which is proved to be large enough by the value of the adjusted R-squared. The explanatory power, in terms of independent variables and size of sample, of the model is satisfactorily high.

The F-statistic of the model in both results is about 1400 and the p-value of F-statistic is 0. Same as the previous model, there is a probability of 0% for coefficients of all independent variables to be zero. This means that the regression model of the Lok Ma Chau extension is statistically significant.

The p-value of t-statistic of every independent variable in both results, except the interaction of railway extension and region closer to CBD, is equal to 0. Most independent variables are statistically significant to variation of the dependent variable at the 1% level. For the interaction of railway extension and region closer to CBD, the p-value of t-statistic is above 0.01 but below 0.05. The impact of it is thus treated as significant at the 5% level. By R-squared, F-statistic and t-statistics statistics, the whole model of the Lok Ma Chau extension and the impact of each independent variable included are statistically significant and possess high explanatory power.

5.3 Analysis of Result

Various independent variables in the models exert different effects, in terms of extent and direction, to the price of railway residential property. The extent and direction of the effects exerted are based on the respective coefficients. The coefficients refer to percentage changes of the price of railway residential property as semi-logarithmic functional form is used.

5.3.1 Model of East Tsim Sha Tsui Extension

Floor Level (FLOOR)

The coefficient of the floor level in both original and modified results is about .0.003 and positive. It shows that the price of railway residential property will increase by

0.3% when the floor level rises by 1 storey. The impact is statistically significant at the 1% level while the p-value of t-statistic is equal to 0.

The positive impact of the floor level is expected. A higher floor level usually enjoys a better external view and quieter living environment. Also, undesirable air pollutants are less likely to reach units in a higher floor level. People should be willing to pay more for a residential unit to gain such benefits.

Building Size (GFA)

For the building size, the coefficient in both results is equal to 0.001. The sign of it is positive as predicted. The coefficient indicates that the increase in the gross floor area by 1 meter square will cause the price of railway residential property to increase by 0.1%. The t-statistic of the building size has a relatively high value. With the 0 p-value of t-statistic, the impact of the building size is shown to be significant at the 1% level.

Residents of a resident property with larger gross floor area can enjoy more space for living. They would like to pay for extra gross floor area. Hence, the property price should increase with the building size.

Building Age (AGE)

Railway residential properties in the model are transacted at different age. The negative coefficient of the building age in both results shows the inverse relationship between building age and the price of railway residential property. The value of the coefficient is about -0.003. It indicates that a year increase in the building age will bring a 0.3% drop in the price of railway residential property. The p-value of t-statistic has a very low value. The impact of the building age is statistically significant at the 1% level.

As the building age of a residential property is a general indicator for its condition and appearance. The condition and appearance undergo deterioration progressively unless the property is renovated. The higher building age thus leads to a lower property price.

Sea View (SEAVIEW)

Some residential units of Royal Peninsula in the model have the scenery of Victoria Harbour. The coefficient of the sea view in both results is about 0.11. The 0 p-value of t-statistic proves that the sea view is a significant attribute to the change of the price of railway residential property at the 1% level. Therefore, the presence of sea view contributes 11% increase in the price of railway residential property.

A residential unit with sea view provides a scenic and comfortable living environment to residents. Residents would like to pay a premium for the presence of sea view. The empirical results align with the prediction.

Region Closer to CBD (RCC)

In this model, the railway residential properties located near Hung Hom Station are classified as those located in the region closer to the CBD. The coefficient of the respective dummy variable in the results is positive and ranging from 0.58 to 0.59. It represents that the price of railway residential property in the region closer to the CBD is higher than that in the remote region by 58% to 59%. The impact is statistically significant at the 1% level as the p-value of t-statistic is equal to 0.

Haig's theory can be verified in the model. Properties staying closer to the CBD should have higher prices as there is a relative advantage of lower transportation costs.

Interaction of Railway Extension and Region Closer to CBD (RE*RCC)

This is the major independent variable in this study. The coefficient of it represents the effect of the East Tsim Sha Tsui extension on the price gradient of railway residential properties. The negative sign of the coefficient and low p-value of t-statistic prove that the price gradient is significantly reduced by the East Tsim Sha Tsui extension at the 1% level. This is an important finding.

The magnitude of the coefficient and t-statistic in the modified results, which exempt transaction records in the first 3 months after operation, are higher than those in the original results. More sharp and significant results means that time is really needed for the relative price levels to reach a steady state due to people's expectation and adaptation to the railway extension.

5.3.2 Model of Lok Ma Chau Extension

Floor Level (FLOOR)

The coefficient of the floor level in both original and modified results of the Lok Ma Chau extension model is positive and equal to about 0.005. The price of railway residential property will rise by 0.5% when the property is located at 1 higher storey. The p-value of t-statistic equals 0. The price of railway residential property is thus significantly affected by the floor level at the 1% level. People would like to pay a premium for benefits of higher floor level.

Building Size (GFA)

The value of the positive coefficient of the building size in both results is about 0.002. This means that if the gross floor area of a railway residential property increases by 1 meter square, the price of it will rise by 0.2%. And the effect is statistically significant at the 1% level as the p-value of t-statistic is 0.

Building Age (AGE)

The building age also exerts a negative impact to the price of railway residential property in this model. The coefficient of the building age is negative and equal to about -0.011 in both results. When the building age of a railway residential property increases by 1 year, the price of it will decrease by 1.1%. The p-value of t-statistic is 0. This means the negative impact is significant at the 1% level. The property will deteriorate with the building age. People would pay less for the property with worse condition and appearance.

Sea View (SEAVIEW)

There are some residential units of Uptown Plaza in the model with the scenery of Tolo Habour. The coefficient of the sea view dummy variable is positive and about 0.12 in both results. It indicates that people are willing to pay 12% more to purchase a railway residential property with sea view. And this effect of the sea view is statistically significant at the 1% level as the p-value of t-statistic is 0.

Region Closer to CBD (RCC)

In the model of Lok Ma Chau extension, the railway residential properties located near Tai Po Market Station are regarded as those situated in the region closer to the CBD. This dummy variable has a positive coefficient ranging from 0.31 to 0.32 in the results. A railway residential situated in the region closer to the CBD has 31% to 32% increase in price, comparing with those located in the region apart from the CBD. This attribute affects the price of railway residential property significantly at 1% level while the p-value of t-statistic equals 0.

Interaction of Railway Extension and Region Closer to CBD (RE*RCC)

Similar to the other model, the coefficient, which represents the change in the price gradient, of this interactive independent variable is negative. Hence, Lok Ma Chau extension causes a decline in the price gradient of railway residential properties. Base on the p-value of t-statistic, the railway extension exerts significant impact on the price gradient at the 5% level.

The magnitude of the coefficient and t-statistic obviously rise after the results are modified by exempting transaction data in the first 3 months after operation. More sharp and significant results can be obtained if transaction data before complete development of people's expectation and adaptation is eliminated.

5.3.3 Comparison of Price Gradient Variation in Two Models

In order to test the second hypothesis, the change of the price gradient of railway residential properties in the model of East Tsim Sha Tsui extension would be compared with that in the model of Lok Ma Chau extension. The coefficients of the interactive independent variable in both original and modified results of the two models are compared. The significance of the difference is tested by the t-test.

For the original results, the magnitude of the coefficient in the model of East Tsim Sha Tsui extension is higher than that in the model of Lok Ma Chau extension by 0.001. The t-statistic for this difference is 4.499, which is higher than the critical one-tailed value at the 1% significance level and respective degree of freedom. Thus, East Tsim Sha Tsui extension causes a significantly greater decrease in the price gradient of railway residential properties than Lok Ma Chau extension.

In the modified results, the magnitude of the coefficient in the model of East Tsim Sha Tsui extension is lower than that in the model of Lok Ma Chau extension by 0.002. The t-statistic for the difference equals 5.912, which is again higher than the critical one-tailed value at the 1% significance level and respective degree of freedom. Hence, when interpreting results exempting transaction data in the first 3 months after operation, Lok Ma Chau extension leads to a significantly greater decline in the housing price gradient along railway than East Tsim Sha Tsui extension.

The original and modified results give different answers to the question. However, the interpretation from the modified results is more reliable. It is because more accurate results are obtained by rejecting records before complete development of public's expectation and adaptation to a railway extension.

5.4 Implication to Hypothesis

5.4.1 Implication to First Hypothesis

"***A railway extension will lead to a decline in the price gradient of railway residential properties.***"

Either in the model of East Tsim Sha Tsui extension or that of Lok Ma Chau extension, the coefficient of the interactive independent variable is negative and statistically significant in both results. The situation is the same as that predicted. A railway extension will reduce the price gradient of railway residential properties.

Alcaly (1976)'s theories on the diminished price gradient after a transportation improvement are followed. A railway extension is a transportation improvement, which can enhance the accessibility and reduce transportation costs in remote regions. Tai Wai and Sheung Shui are regarded as remote regions in different models. After respective railway extensions, they gain in accessibility and save transportation costs in a relatively high extent, comparing with regions closer to the CBD. Although Sheung Shui hasn't become more accessible to the CBD after Lok Ma Chau extension, but it can gain extra and direct accessibility to Lok Ma Chau. No matter where the railway extends to, the relative disadvantage of accessibility in remote regions has been reduced in both cases. In other words, the relative advantage of regions closer to the CBD is diminished. Then the increase of rail housing prices in remote regions becomes higher in extent than that in regions closer to the CBD. This leads to a decline in the price gradient of railway residential properties. The decline is more concrete after a period of operation as time is required for the relative railway residential property price levels to reach a steady level

To sum up, a railway extension reduces the relative advantage of accessibility in regions closer to the CBD. The price gradient of railway residential property is then declined. Therefore, the first hypothesis of this study cannot be refuted.

5.4.2 Implication to Second Hypothesis

"A railway extension to the CBD will lead to a greater decline in the price gradient of railway residential properties than that to a non-CBD district."

By comparing the modified empirical results of the two models, the coefficient of the interactive independent variable in the model of Lok Ma Chau extension is significantly more negative than that of East Tsim Sha Tsui extension. This shows that a railway extension to a non-CBD district will lead to a significantly greater decline in the price gradient of railway residential properties than that to the CBD. The phenomenon indicated by the modified results is opposing to the second hypothesis.

When setting up the second hypothesis, it is believed that people may put the accessibility to the CBD at a higher priority when purchasing residential properties as they generally want to save transportation costs to their employment locations and the business centre. The price gradient of rail residential properties is expected to be reduced to a greater extent by a railway extension to the CBD. However, this is not supported by the empirical results.

The unexpected results exist possibly because the subjected target used in the model of non-CBD district extension, Lok Ma Chau Station, is connected with a border control point to mainland China. The railway extension to Lok Ma Chau is not a typical extension to a non-CBD district. It is a way for passing the border and travel between Hong Kong and mainland China other than Lo Wu Station.

The price gradient in the model of Lok Ma Chau extension is constructed by prices of rail residential properties in Sheung Shui and Tai Po Market. Sheung Shui is the nearest town to the border between Hong Kong and mainland China. There are a proportion of people travelling between Hong Kong and mainland China regularly. The accessibility and transportation costs to their destinations in mainland China is crucial to them. They put the accessibility and transportation costs to their destinations in mainland China at a high priority. They would like to live in a region close to the border especially Sheung Shui. This can help them to save the transportation costs to their destinations in mainland China. Time but not money, is the crucial transportation cost they can save as the difference between fare prices in Sheung Shui and those in regions further apart is not significantly large.

The railway extension to Lok Ma Chau is an additional way of crossing the border between Hong Kong and mainland China apart from Lo Wu Station. People can travel to destinations in mainland China more efficiently after the extension. Once the transportation costs in terms of time to destinations in mainland China is further saved by the railway extension to Lok Ma Chau, people would like to pay more to purchase railway residential properties in Sheung Shui. The prices of railway residential properties there will thus increase in a great extent. This will strongly reduce the price difference between railway residential properties in Sheung Shui and Tai Po Market. The extent of the reduction is even larger than that caused by the railway extension to the CBD.

With the transaction data in the first 3 months, the results are different. The price gradient in the model of CBD extension was reduced to a greater extent. This is because people's expectation and adaptation to the Lok Ma Chau Station was not totally developed at the beginning of operation. Moreover, complaints to the station and Lok Ma Chau Spur Line Control Point received at the beginning may exert negative impact to people’s expectation. There were four types of complaints commonly received when the station and the control point were just opened. Firstly, instructions in the station and the control point were insufficient. People easily went to wrong directions. Secondly, there was no route provided for getting to the public transport interchange nearby after entering the station. People entering the station were not allowed to choose other transports to leave. Thirdly, the signal received by mobile phones was weak in the station and the control point. It was difficult for people to contact others by mobile phones in those areas. Fourthly, apart from Shenzhen Metro, few transports were available there for people to travel to other parts of mainland China. The impact of Lok Ma Chau extension was masked at early time of operation. The reduction in the price gradient has not yet been steady.

To sum up, base on the modified results eliminating transaction records at the beginning of operation, the railway extension to the CBD does not lead to a greater decline in the price gradient of railway residential properties than that to a non-CBD district. Therefore, the second hypothesis can be refuted.

CHAPTER 6: CONCLUSION

6.1 Summary of Finding

This study focuses on the effects of railway extension to prices of railway residential properties. After reviewing a fair number of literatures, it is found that a railway extension should be able to reduce the housing price gradient along the railway line.

To collect empirical evidence in the context of Hong Kong, transaction records of railway residential properties in 4 districts are used to investigate the effects of East Tsim Sha Tsui extension and Lok Ma Chau extension on property price gradient along the East Rail line. Hedonic price model is applied to examine the effects, in which a variety of housing attributes are taken into account. Tsim Sha Tsui extension represents the railway extension to the CBD while Lok Ma Chau extension signifies that to a non-CBD district. The effects of two models of railway extensions are compared with the association of unpaired t-test.

After analyzing the empirical results of the two models, the first hypothesis, which claims that a railway extension will lead to a decline in the price gradient of railway residential properties, cannot be refuted. This finding is consistent with Haig's theory on transportation improvement. When a railway line is extended, remote regions will gain in accessibility and save transportation costs in a greater extent. The relative advantage of accessibility in regions closer to the CBD is reduced. This will reduce the price gradient of railway residential properties.

Nevertheless, the second hypothesis, which proposes that a railway extension to the CBD will lead to a greater decline in the price gradient of railway residential properties than that to a non-CBD district, can be refuted by the empirical results. It is believed that the unexpected results are due to the special nature of Lok Ma Chau Station and the need of people choosing to live in Sheung Shui. Lok Ma Chau Station is not only a station bringing passengers to a non-CBD district area. It is also connected with the border control point to Mainland China. A proportion of people choosing to live in Sheung Shui are believed to be those need to travel between Hong Kong and mainland China more often. They consider more about the accessibility and transportation costs to their destinations in mainland China. When the transportation costs in terms of time to their destinations in mainland China are saved by Lok Ma Chau extension, people would like to pay a high premium for railway residential properties in Sheung Shui. Thus the price gradient is reduced to an unexpected high extent.

In addition, it is discovered that time is really required for the relative price levels to reach a steady state due to the people's expectation and adaptation to the change. This is consistent with Chau and Ng's findings. After rejecting transaction records at the beginning of the change, the significance of the respective coefficient will be higher and the magnitude will be sharper.

The findings of this study suggest that the price difference of railway residential properties will be reduced after a railway extension. The nature of the extension is a factor to the extent of reduction. The government and railway company can consider this when planning new railway extension and railway property development. Developers should also take into account of the impact of railway extensions when valuing and planning development projects along the railway.

6.2 Limitation of Study

In this study, in order to study the effects of railway extensions, the transaction records before and after the operation of railway extensions are used. It is probable that some exogenous factors other than matters regarding railway extensions have affected the prices of railway residential properties throughout the whole time frame. The factors may be economic structure changes, financial market fluctuation and demographic changes. Although these factors may mask the pure effects of railway extensions, it is extremely difficult to isolate them.

Lok Ma Chau Station has just been opened for one and half year. So the number of transaction records after the operation of Lok Ma Chau Station is limited. This can affect the accuracy of the empirical results.

Also, there may be some relevant variables missing in the regression equation. Attributes such as shape of a unit, orientation of a unit and noise level can also affect the prices of railway residential properties. However, the inclusion of these variables is not feasible as such data are not easily available.

If more data is available, this study will have a considerable scope for further improvement. Notwithstanding the limitations mentioned above, the validity of this study is satisfied.

6.3 Area for Further Study

If unlimited resources are available, Transaction data of more railway estates and all relevant attributes would be adopted for analysis to enhance the accuracy and explanatory power of the empirical results. In addition, the effects f railway extensions to areas with different natures such as extensions to industrial areas, extensions to commercial areas and extensions to recreational areas would be studied and compared.

In the coming future, new extensions of MTR including Tseung Kwan O Line Phase 2, Kowloon Southern Link, Shatin to Central Link, Kwun Tong Line Extension, West Island Line and South Island Line will be developed. Te effects of these railway extensions on railway residential property prices can be further studied when relevant data is available.

Apart from railway residential properties, there are numerous railway commercial and retail properties. How railway extensions may affect the prices of railway commercial and retail properties is another potential area that can be examined.

The effects of different types of transit systems on property market can be considered too. Extensions in light rail system, bus network and other kinds of transit systems may influence the nearby property prices. The effects of extensions of those transit systems can be compared with that of railway extensions.

Moreover, the unexpected results for the second hypothesis are explained by the special nature of Lok Ma Chau Station and the need of people choosing to live in Sheung Shui. Nevertheless, there is lack of empirical results to support that. Researches can be done to determine the proportion of people choosing to live in Sheung Shui due to the accessibility to mainland China and how improving accessibility to mainland China is important to them.

Although the study of the effects of railway extensions on prices of railway residential properties is extensive enough, the above areas can still be further studied.

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APPENDIX

Appendix 1 – Location plans of subjected railway residential estates

Royal Peninsula

Grandeur Garden

Uptown Plaza

Sheung Shui Town Centre

Source: Centaline Agency Limited (2009)

Appendix 2 – Subjected residential properties with sea view

Estate	Block	Floor	Unit
Royal Peninsula	1	20-35	A, B, C, D, E, F
	2	20-42	D, E, J, K, L, M, N
	3	20-42	E, F, G, H
	4	20-39	A, B, C, D, E, F, G
	5	20-39	A, B, C, D, E, F, G
Uptown Plaza	4	15-26	C, D, E, F
	5	15-26	E, F, G, H

Source: Centaline Agency Limited (2009)

Appendix 3 – Price indices of private domestics from 1996 to 2008

Year	Month	Index
1996	1	105.2
	2	108.5
	3	112.8
	4	112.1
	5	113.5
	6	115.0
	7	114.6
	8	117.4
	9	118.2
	10	123.1
	11	128.0
	12	134.5
1997	1	142.7
	2	154.3
	3	162.2
	4	157.0
	5	172.3
	6	172.0
	7	167.2
	8	171.1
	9	170.3
	10	172.9
	11	160.5
	12	155.0

Year	Month	Index
1998	1	143.7
	2	136.6
	3	138.7
	4	134.3
	5	127.6
	6	112.5
	7	108.0
	8	104.5
	9	98.5
	10	95.6
	11	100.3
	12	104.6
1999	1	103.8
	2	102.0
	3	101.7
	4	102
	5	102.9
	6	102.3
	7	101.6
	8	100.5
	9	97.1
	10	95.8
	11	94.3
	12	95.7

Year	Month	Index
2000	1	97.5
	2	97.5
	3	95.3
	4	93.9
	5	90.3
	6	86.0
	7	86.6
	8	87.2
	9	88.2
	10	87.0
	11	83.7
	12	81.8
2001	1	80.7
	2	80.2
	3	82.1
	4	82.2
	5	80.5
	6	80.9
	7	80.2
	8	78.5
	9	77.2
	10	74.1
	11	73.6
	12	73.8

Year	Month	Index
2002	1	74.1
	2	73.9
	3	73.3
	4	72.3
	5	72.4
	6	71.9
	7	70.9
	8	68.3
	9	66.7
	10	65.4
	11	65.1
	12	64.8
2003	1	63.6
	2	63.4
	3	61.2
	4	60.5
	5	59.7
	6	59.3
	7	58.4
	8	58.6
	9	60.9
	10	63.4
	11	64.3
	12	65.4

Year	Month	Index
2004	1	69.5
	2	73.2
	3	78.1
	4	79.4
	5	77.5
	6	74.7
	7	74.9
	8	77.6
	9	80.9
	10	84.1
	11	82.7
	12	83.3
2005	1	85.7
	2	89.4
	3	94.6
	4	95.4
	5	95.3
	6	92.9
	7	92.8
	8	93.9
	9	94.0
	10	91.8
	11	88.5
	12	90.1

Year	Month	Index
2006	1	90.8
	2	91.1
	3	92.6
	4	93.4
	5	94.0
	6	92.3
	7	91.9
	8	93.0
	9	93.3
	10	93.1
	11	93.0
	12	93.8
2007	1	95.2
	2	96.6
	3	97.9
	4	98.7
	5	100.5
	6	101.6
	7	102.8
	8	104.0
	9	105.3
	10	108.5
	11	113.3
	12	117.9

Year	Month	Index
2008	1	123.2
	2	125.5
	3	126.4
	4	124.7
	5	126.4
	6	126.6
	7	124.9
	8	122.9
	9	121.9
	10	114.1
	11	104.4
	12	103.6

Source: Rating and Valuation Department (2009)